REGION 5 RAC2

REMEDIAL ACTION CONTRACT FOR

Remedial, Enforcement Oversight, and
Non-Time Critical Removal Activities at Sites of Release
or Threatened Release of Hazardous Substances in Region 5

FEASIBILITY STUDY REPORT
ALLIED PAPER LANDFILL—OPERABLE UNIT 1
Allied Paper/Portage Creek/Kalamazoo River Site
Feasibility Study
City of Kalamazoo, Michigan

WA No. 109-RICO-059B/Contract No. EP-S5-06-01

November 2013

PREPARED FOR

U.S. Environmental Protection Agency

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Feasibility Study Report

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Acronyms and Abbreviations

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
BERA	baseline ecological risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
the City	the City of Kalamazoo
COC	contaminant of concern
EO	Executive Order
FIELDS	FIeld EnvironmentaL Decision Support
FRDL	Former Residuals Dewatering Lagoon
FML	flexible-membrane liner
FS	feasibility study
GCL	geosynthetic clay liner
GDC	geosynthetic drainage composite
GRA	general response action
GSI	groundwater–surface water interface
HHRA	human health risk assessment
HRDL	Historic Residuals Dewatering Lagoon
IRM	Interim Response Measure
MCL	Michigan Compiled Laws
MDEQ	Michigan Department of Environmental Quality
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligram per kilogram
MHLLC	Millennium Holdings, LLC
NREPA	Natural Resources and Environmental Protection Act of 1994
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PA	Public Act
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxin
PCDF	polychlorinated dibenzofuran

PCOC	potential contaminant of concern
PRG	preliminary remediation goal
RAO	remedial action objective
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
the site	Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
SVOC	semivolatile organic compound
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TCRA	time-critical removal action
TSCA	Toxic Substances Control Act
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
yd^3	cubic yards

SECTION 1
Introduction

The Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site (the site) is located in Allegan and Kalamazoo counties in southwest Michigan (Figure 1-1). The site includes 80 miles of the Kalamazoo River, adjacent floodplains and wetlands, paper-residual disposal areas, and former paper mill properties, all pervasively contaminated with polychlorinated biphenyls (PCBs) as the result of the recycling of carbonless copy paper. The site was listed on the National Priorities List in 1990. The State of Michigan posted fish advisories warning against any consumption of certain Kalamazoo River fish within the site as early as 1977. The advisories remain in effect. Currently, the site is divided into the following operable units (OUs):

- OU1: Allied Paper Landfill
- OU2: Willow Boulevard/A Site Landfill
- OU3: King Highway Landfill
- OU4: 12th Street Landfill
- OU5: Kalamazoo River and Portage Creek

This feasibility study (FS) report evaluates potential remedial alternatives that may be implemented at the Allied Paper Landfill/OU1. OU1 occupies 89 acres, including Portage Creek between Cork and Alcott streets within the City of Kalamazoo (the City). Investigation efforts were carried out in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1996, and pursuant to an Administrative Order on Consent issued by the State of Michigan in 1990 (Final Order No. DFO-ERD-91-001). In 2008, the Michigan Department of Environmental Quality (MDEQ) summarized the remedial investigations in the *Allied Paper, Inc., Operable Unit Remedial Investigation Report* (remedial investigation [RI] report; MDEQ 2008). Upon finalization of the RI report, the U.S. Environmental Protection Agency (USEPA) assumed the responsibility of lead agency for the remainder of work to be done at OU1.

The FS is the mechanism for the development, screening, and detailed evaluation of alternative remedial actions at a Superfund site. The RI and FS are conducted concurrently—data collected in the RI influence the development of remedial alternatives in the FS, which in turn affect the data needs and scope of treatability studies and additional field investigations. This FS report presents the remedial action objectives (RAOs), the identification and evaluation of remedial technologies, the development of alternatives to address OU1-specific risks to human health and the environment, and the evaluation of the alternatives. The results of the RI report and recent supplemental investigation work were reviewed and incorporated throughout the FS process.

The FS report includes the following sections:

- Section 1: The background and history of OU1, a summary of prior release actions, potential contaminants of concern (PCOCs), and key elements in the RI report, findings of the recent supplemental groundwater investigation report, and USEPA´s preliminary remedial goals (PRGs)
- Section 2: Identification of general response actions (GRAs), establishment of RAOs, identification of PRGs and contaminants of concern (COCs), and identification and development of possible federal and state applicable or relevant and appropriate requirements (ARARs)
- Section 3: Identification and review of technologies and process options, and presentation of a range of alternatives designed to achieve the risk-based RAOs established for OU1
- Section 4: Descriptions of the remedial alternatives developed for OU1
- Section 5: Analysis of each alternative relative to a series of evaluation criteria defined in CERCLA
- Section 6: Comparative analysis of the alternatives relative to the CERCLA evaluation criteria
- Section 7: References

1.1 OU1 Background and History

OU1 is located within the City of Kalamazoo, Michigan, and is defined as the areas between Cork Street and Alcott Street where contamination from paper operations is located. OU1 includes areas that are zoned for residential, commercial, and manufacturing uses (Figure 1-2). Cork Street forms the southern boundary, and Alcott Street runs along the northern boundary. Residential development exists along a portion of the eastern side, and a railroad corridor forms a portion of the western boundary. Commercial and manufacturing properties are located north and south of OU1 and along portions of the eastern and western sides of the property.

The Monarch Mill was built by the Kalamazoo Paper Company in 1875. The Bryant Mills (A, B, C, D, and E) were built by the Bryant Paper Company in 1895 and produced a variety of high-quality paper products for the next 94 years.

In large part, PCBs were introduced to OU1 through the recycling of carbonless copy paper that contained PCBs as a carrier for the ink. Carbonless copy paper contained PCBs between 1957 and 1971 (USEPA 1977), and PCBs remained in the recycle stream after that period as the carbonless copy paper supply was depleted. The key risk management goals established for OU1 are associated primarily with exposure to PCBs in the various media.

When mills recycled waste paper that included carbonless copy paper, PCBs were present in the wastewater produced from the recycling process. Typically, the wastewater contained large quantities of suspended particles—primarily cellulose and clay. The solid components of the recycling process adsorb or contain high concentrations of PCBs. PCBs were present in the recycling process from at least 1957 until well after production of carbonless copy paper containing PCBs stopped in the 1970s. In the 1950s, mills began building clarifiers and dewatering or settling lagoons to remove most of the particles, and the clarified wastewater was discharged to rivers and creeks (in this case, Portage Creek). At OU1, the legacy of this practice is PCB-containing materials in the Bryant Historic Residuals Dewatering Lagoons (HRDLs) and Former Residuals Dewatering Lagoons (FRDLs), the Monarch HRDL, and the Former Bryant Mill Pond. The PCB-containing materials, referred to in this report as residuals, have been the focus of the investigations conducted at OU1 (MDEQ 2008).

The Alcott Street Dam was built in 1895 to provide hydroelectric power and to process water for the Bryant Paper Mills. The dam also impounded Portage Creek to form the Bryant Mill Pond, as described in the RI report (MDEQ 2008). In 1976, Allied Paper Company obtained a permit (No. 75-12-187) from the Michigan Department of Natural Resources to draw down the reservoir in an effort to reduce contamination impacts through discharge of sediment or groundwater to Portage Creek. Surface water in Portage Creek was lowered 13 feet during the drawdown and exposed sediments that had accumulated over the many years of mill operations. The dam is currently owned by Lyondell Trust, created as a result of the bankruptcy of Millennium Holdings, LLC (MHLLC), and is classified as a high-hazard structure (ARCADIS BBL 2006). The gates have been permanently removed, and the dam was last inspected by MHLLC in May 2006.

1.2 Subareas

OU1 consists of the following areas and subareas based on historical operations, as depicted in Figure 1-2 and described in detail in the RI report:

- **Former Operational Areas—**Consists of Bryant HRDLs and FRDLs, Monarch HRDL (including the Former Raceway Channel), Former Type III Landfill, and the Western Disposal Area. Portions of contiguous properties, including the adjacent Panelyte Marsh, Panelyte Property and the Conrail Railroad Property, and the State of Michigan's Cork Street Property, are included in the Former Operational Areas as a result of waste materials that have encroached into these areas from the Western Disposal Area.
- **Former Bryant Mill Pond Area—**Includes the area within the boundary of the Former Bryant Mill Pond, defined by a historical impoundment elevation of 790 feet above mean sea level (amsl). A portion of the Bryant Mill property south of Alcott Street is included within the area.
- **Residential Properties (Outlying)—**Residential Properties that are part of the site but are not contiguous with the Former Operational Areas include the following: Clay Seam Area, East Bank Area, four adjacent residential

properties (Golden Age Retirement Community and three single-family residences), and property owned by Lyondell Trust (formerly MHLLC) but used by owners of the three single-family residences (MDEQ 2008).

- **Commercial Properties (Outlying)—**Commercial properties that are part of the site but are not contiguous with the Former Operational Areas include Goodwill, Consumers Power, Filter Plant and Alcott Street Parking Lot (owned by Lyondell Trust [formerly MHLLC]) south of Alcott Street), and Former Bryant Mill property.

1.3 Prior Response Actions

OU1 was designated as a distinct OU within the site, in part, so cleanup activities could proceed on a separate schedule relative to the remedial activities developed for the site as a whole. Between 1998 and 2004, a series of actions were completed to minimize exposure potential by consolidating and capping a portion of the PCB-containing materials at OU1. The primary actions performed to date are summarized in the following subsections.

1.3.1 Time-critical Removal Action at the Former Bryant Mill Pond

In 1998 and 1999, USEPA completed a time-critical removal action (TCRA) at the Former Bryant Mill Pond. The work involved the excavation of 146,000 cubic yards (yd^3) of PCB-containing sediments, residuals, and soils and placement of the materials into the Bryant HRDLs and FRDLs. The excavation was performed in segments by using stream diversions to expose the sediment and excavate in dry conditions. After excavation, confirmation samples were collected, and the area was subsequently backfilled and stream diversions removed (Weston 2000).

The initial excavation was performed with a PCB concentration action level of 10 milligrams per kilogram (mg/kg), and a goal of achieving post-excavation PCB concentrations less than or equal to 1 mg/kg. At locations where initial post-excavation PCB sampling results exceeded this goal, an additional 6 inches of material was removed and another post-excavation sample was collected at the final extent. USEPA then backfilled the excavated area with an amount of clean fill approximately equal to the volume of materials removed. The thickness of the backfill layer ranged from approximately 1 foot at the upstream end of the Former Bryant Mill Pond to approximately 10 feet near the Alcott Street Dam. The surface of the materials placed in the Bryant Mill Pond was graded, seeded, and revegetated with native grasses and plants, and the habitat was restored (Weston 2000).

The post-excavation samples collected from the final excavation were equal to or below the target PCB concentration of 1 mg/kg established for the TCRA in 435 of the 440 samples. The PCB concentration in the remaining five samples ranged from 1.8 mg/kg to 3.8 mg/kg. A total of 410 of the 440 final post-excavation samples were below the 0.33 mg/kg screening-level criterion protective of people eating fish (Weston 2000) recommended by MDEQ in the RI report (MDEQ 2008).

PCBs were the driver for removal at the Bryant Mill Pond. Confirmation samples were not collected for other PCOCs that were identified in the RI. However, the RI identified that it is expected that PCOCs are collocated with the PCB residuals, and addressing PCB contamination is expected to address other PCOCs found at OU1. In addition, excavated areas were backfilled with 1 to 10 feet of clean fill and restored with native vegetation, thereby reducing the risk of direct dermal contact and erosion to Portage Creek in the excavated areas. The completeness of the TCRA is evaluated in development of the remedial alternatives and consideration of institutional controls as discussed in Section 4. However, the alternatives do not include additional excavation for the Bryant Mill Pond where removal activities occurred below 790 feet amsl.

1.3.2 Interim Response Measures

Beginning in the early to middle 1990s, MHLLC conducted a series of small-scale Interim Response Measure (IRM) activities to restrict access to OU1 and to provide erosion control and stabilization in certain areas. MHLLC also removed remnant structures, such as the Filter Plant, from the historical mill Operational Areas. The former Bryant Clarifier remains in place. The various components of the IRM are described in the following subsections.

1.3.2.1 Bryant HRDLs and FRDLs

After completion of the Bryant Mill Pond TCRA, MHLLC carried out IRM activities to stabilize the area where USEPA disposed of the materials excavated from the Former Bryant Mill Pond and to further mitigate the exposure to or transport of PCBs at OU1. The IRM completed at the Bryant HRDLs/FRDLs is summarized briefly as follows and described in detail in the RI report (MDEQ 2008):

- Installation of sealed-joint sheet pile along the Bryant HRDLs and FRDLs adjacent to Portage Creek to stabilize the perimeter berms that separate the materials in the Bryant HRDLs and FRDLs from the Portage Creek floodplain (Figure 1-2). The response action was completed in 2001.
- Removal of several hundred cubic yards of soil containing residuals from locations between the sheet pile wall and Portage Creek and consolidation into the Bryant HRDLs and FRDLs. The material was removed in 2000 and 2003 to minimize the potential for PCB releases to Portage Creek.
- Construction of an engineered composite cap for the Bryant HRDLs and FRDLs with its design based on Michigan Act 451 Part 115, solid waste regulations. The cap, which covers the Bryant HRDLs and FRDLs, was constructed between 2000 and 2004.
- Installation and operation of a groundwater extraction system inside the sheet pile wall and beneath the cap (Figure 1-3). The purpose of the system was to mitigate groundwater mounding behind the sheet pile, which might compromise the cap or inundate otherwise unsaturated residuals and increase the potential for migration of PCBs to the creek.

The cap was installed to act as a barrier to minimize the potential for direct contact and reduce infiltration of rainwater. MDEQ expressed concern that the flexible-membrane liner (FML) was left exposed for substantial periods of time and was degraded by exposure to sunlight and punctures from wildlife. MHLLC subsequently repaired the cap, rather than replaced as recommended to address MDEQ concerns. MDEQ remains concerned due to the number and quality of the repairs (MDEQ 2008).

1.3.2.2 Portage Creek Floodplain

In 2002, MHLLC conducted an IRM to remove approximately 1,700 yd^3 of soils and sediments containing residuals located in the floodplain on the eastern side of Portage Creek (referred to as the East Bank Area—Figure 1-2) and PCB-containing soils between the sheet pile and the creek. The materials were consolidated into the Bryant FRDLs prior to construction of the landfill cap. The IRM methods and cleanup targets were similar to those used by USEPA during the TCRA. Results of all post-excavation confirmation samples were below the target PCB removal criterion of 1 mg/kg, and the excavation was backfilled with a minimum of 1 foot of clean fill. The area was subsequently seeded and revegetated with native plants to restore the existing habitat (MDEQ 2008).

Where the IRM actions were taken, materials exceeding 1 mg/kg were removed and were verified by confirmation sampling. PCB concentrations above 1 mg/kg exist in areas of the floodplain where the IRM was not performed, specifically the seep areas. The areas will be considered for action in this FS.

1.3.2.3 Filter Plant

The Filter Plant is a commercial property encircled by the Panelyte Property (Figure 1-2). The Filter Plant was demolished in 2006 by MHLLC. Work done in the area was not observed by the Agencies. As a result, one of the common elements of the alternatives includes evaluation of the area in the remedial design (RD) to verify cleanup levels were met.

1.4 Remedial Investigation

Early investigative efforts recognized that if the full extent of PCBs were identified and appropriately remediated, then other associated substances at OU1 would be appropriately addressed. The RI therefore focused on PCBs for identifying the extent of contamination (MDEQ 2008). In addition to PCBs, several inorganics, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs) were detected in soils, sediments, and groundwater. The following summarizes the RI report conclusions:

- The actions taken at OU1 have caused substantial changes to the distribution of contamination and the topography such that some of the data collected in the early phases of the RI no longer describe current conditions. Although some earlier-collected data have been excluded, a considerable body of information is available that is sufficient to complete the FS, assess the present state of the OU, and inform decisions on future remedial actions.

- Target analyte list inorganic constituents in soils and sediments appear to be associated with the PCBs identified at OU1.
- Soils with inorganic impacts may be acting as a source resulting in low-level impacts to the groundwater.
- Target compound list (TCL) VOCs in soils, sediments, and groundwater do not appear to be associated with contaminant impact identified at OU1. TCL VOC exceedances in soil and sediment were limited to one subsurface soil sample in the Monarch HRDL. The VOC groundwater detections in the most recent sampling event were all below screening criteria.
- TCL SVOCs in soils and sediments appear to have a similar distribution to the contaminant impact based on the data set available.
- The SVOC groundwater impact appears to be much less extensive than the SVOCs in soil at OU1. There were no SVOC exceedances of the screening criteria in the most recent sampling event.
- Concentrations of TCL pesticides did not exceed screening criteria. Pentachlorophenol was detected above screening criteria and is discussed in this report as an SVOC because of its inclusion in the TCL SVOC analyte list.
- TCL pesticides were not present in the groundwater at the time of sampling, which is consistent with the soil and sediment data. One pesticide was detected in a leachate sample below screening criteria, but no exceedances were identified.
- Soils with visual indicators of residual impact can be expected to have PCB concentrations similar to those identified in the Bryant Mill Pond.
- During the most recent sampling, PCBs were detected in several of the groundwater seep monitoring wells located along Portage Creek near the Former Operational Areas, with PCB detections above the groundwater–surface water interface (GSI) screening criteria in two locations.

The evaluation of media and potential exposure pathways at OU1 are discussed further in Section 1.6.

The RI report describes the data collected between 1991 and 2003. The completion of the prior response actions described in Section 1.3 resulted in significant changes in the lateral extent, mobility, and potential exposure pathways at OU1. Summaries of the data included in the RI report regarding the nature and extent of PCBs at OU1 that can be used to describe current conditions, and the key mechanisms of PCB fate and transport are presented in the following subsection. The data in the RI report, which have been augmented by data from the supplemental groundwater investigation report (Appendix A), have been considered in the development and analysis of alternatives presented in this FS report.

1.5 Nature and Extent of Contamination

PCBs are being used as the primary indicator to define the extent of contamination because PCBs are associated with the residuals, entered the waste stream during the recycling of carbonless paper, and because of their frequency of detection. As identified in the RI report, most other PCOCs (inorganics and SVOCs) appear to be collocated with PCBs in the various media.

PCBs are present in the residuals, some of which have eroded and mixed with the soils and/or sediments near or at the ground surface, in certain subareas of OU1, including the Monarch HRDL and Western Disposal Area, for example. In other areas, they are present only beneath buildings, pavement, and/or clean soil or fill materials that serve as barriers to exposure and transport. Examples of the latter include the Alcott Street Parking Area, portions of the Goodwill property, and the private residential properties, where the available data indicate there is approximately 4 feet or more of clean fill on top of the residuals (MDEQ 2008). Figure 1-4 provides the aerial extent of PCB-containing surface soils and residuals as identified in the RI report. Figure 1-5 provides the aerial extent of PCB-containing soils and residuals.

The extent of PCBs has not been confirmed on parcels owned by Consumers Power, the Golden Age Retirement Community, and certain single-family residential parcels. However, soil borings from adjacent properties had visual and/or analytical confirmation of PCBs, and it was conservatively assumed that PCBs are present. A common element of the alternatives (except no action) is additional surface and subsurface soil investigations during the remedial design to either confirm the absence of PCBs or delineate the extent of PCB-containing soils/residuals.

1.5.1 PCBs

Samples are identified as soil, sediment, or residuals based upon the dominant component or characteristic visually identified during sample collection. Residuals refer to the grey clay and fibrous wood material, which is a waste byproduct from former paper recycling operations. Soils are nonresidual material that is largely native, and sediments are inundated soils. Samples composed primarily of residual material as opposed to soils and sediments are referred to as residuals. When soils or sediments are the primary components of a residual containing mixture, the samples are referred to as soil or sediment, respectively.

PCBs were detected at concentrations exceeding screening criteria in the following areas: in soils and sediments in the Former Operations Area, Former Bryant Mill Pond, and Residential/Commercial Areas; in groundwater in the Western Disposal Area and Bryant HRDLs/FRDLs; and in seeps in the Former Type III Landfill Area adjacent to the Bryant HRDLs/FRDLs. PCB exceedances in groundwater and seeps were only at locations collocated within or immediately adjacent to areas where soils, sediment, or residuals with PCB concentrations exceeding screening criteria were present. The locations suggest the material is acting as a source to groundwater without significant transport away from the material. Figure 1-6 summarizes the samples collected and shows the range of results for samples analyzed for total PCBs in soils, sediments, and residuals.

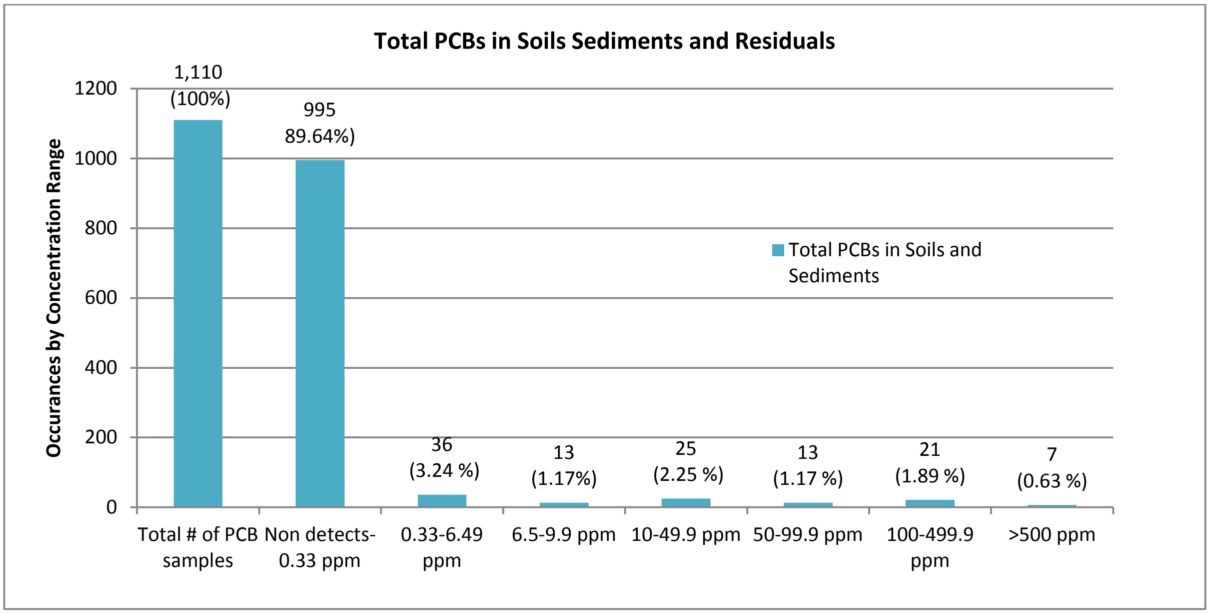
The 66 samples with the highest concentrations of PCBs, those greater than 10 mg/kg, were identified as containing residual material, even if they were labeled as “soil” or “sediment,” with the exception of FLF-1, which had a concentration of 85 mg/kg at the 0- to 0.5-foot interval. Although the boring log did not indicate the presence of residual material in the 0- to 0.5-foot interval of boring FLF-1, residuals were the primary component of the 0.5- to 7.0-foot interval immediately below, and may have been present within the interval sampled. There were an additional 46 residual samples analyzed with PCB concentrations less than 10 mg/kg. Residuals that were visually identified but did not have subsequent analytical testing may have high PCB concentrations, but are not represented in Figure 1-6.

The highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures is referred to as the reasonable maximum exposure (RME) (USEPA 2004). The RME for the site soils and sediments is 60 mg/kg. The RME was calculated as the upper 95 percent confidence limit of the mean concentration in soil, sediment, and residual samples with PCB detections. In performing the calculation, nondetect samples were excluded.

The RI figures were used to evaluate the extent of contamination in soils and sediments requiring remediation at OU1. Figures 4-2A, 4-2B, 4-3A, 4-3B, and summary Tables 4-2A, 4-2C, 4-3A, and 4-3C of the RI report provide PCB screening criteria exceedances in surface soil, subsurface soil, and sediment and are provided in Appendix D.

The Bryant Mill Pond TCRA was performed to remove PCB impacts above the anticipated final remedy criteria for OU1. As summarized in Section 1.3.1, most samples were equal to or below the target PCB concentration of 1 mg/kg. Through excavation and backfill, the Bryant Mill Pond TCRA reduced the extent of the PCB impacts above 1 mg/kg and capped any remaining exceedances (maximum concentration of 3.8 mg/kg) minimizing potential exposure. Generally, no additional remedial actions are being considered for the previously excavated areas within the Former Bryant Mill Pond Area with the exception of the seep areas along the Former Type III Landfill.

FIGURE 1-6
Total PCBs in Soil Sediments and Residuals



The response activities removed or consolidated contaminated material into the capped HRDLs and FRDLs. The actions would minimize the potential for transport to the groundwater and the resulting groundwater impacts. The most recent (2002–2003) groundwater sampling activity results were used in the RI to represent conditions at OU1 after completion of the removal activities. Because the wells included in the sampling events differ between 2002 and 2003, the nature and extent of PCB contamination in groundwater cannot be drawn from either event on its own. For this reason, the 2002 and 2003 data sets should be considered collectively for the most accurate depiction of current groundwater conditions (MDEQ 2008). Older groundwater sampling results are not included because they no longer represent current conditions at OU1. As mentioned in Section 1.4, the data collected before 2002/2003 represent somewhat different site conditions. Much of the earlier data are groundwater samples collected within the Bryant Mill Pond, before highly contaminated material was removed and then consolidated and capped above the water table within the HRDL and FRDL as a part of the TCRA and the IRM.

PCBs were detected at concentrations above the screening levels established in the RI from 3 of 56 monitoring well locations and 2 of 20 seep locations (Appendix D, RI Tables 4-4A and 4-4G, and Figures 4-4A and 4-4B). The groundwater and seep locations are within or adjacent to soil sampling locations where PCBs exceed screening levels. The areas are included in the areas to be considered during the development of the potential alternatives for OU1.

The three groundwater sampling locations at which the PRG for PCBs in groundwater was exceeded are MW-8A and FW-101 in the Western Disposal Area, and MW-122AR in the Bryant HRDLs/FRDLs Area. MW-122AR is within the sheet pile wall that was installed as part of the IRM activities. MW-8A and FW-101 are located in the southwest corner of OU1 in areas where soils exceed the PCB screening levels. The two seep locations in which the groundwater screening level for PCBs was exceeded are SP-G and SP-H in the Former Type III Landfill. The seeps are located a few feet from each other, where residuals remain.

As described in Section 1.3.2.2, an IRM was performed in 2002 where residuals in the East Bank Area and PCB-containing soils between the sheet pile and the creek were excavated and consolidated into the Bryant FRDLs prior to construction of the existing landfill cap. Results of all post-excavation confirmation samples were below the target PCB removal criterion of 1 mg/kg.

Although the Bryant HRDLs and FRDLs cap acts as a barrier to minimize the potential for direct contact, the integrity of the FML may have been compromised and may not be fully mitigating the infiltration of precipitation.

Infiltrating precipitation could form leachate and result in groundwater impacts. As a result, HRDL and FRDL areas are included in the alternatives to be evaluated.

Residuals from the Filter Plant were excavated and disposed of in the Western Disposal Area. As described in Section 1.3.2.3, work done in the area was not observed by the agencies, and as a result, a common element of the alternatives includes evaluation of the area during the RD to verify that cleanup levels were met.

1.5.2 VOCs, SVOCs, Pesticides, and Inorganic Constituents

PCBs are the primary PCOC for OU1. However, SVOCs and inorganic constituents also exceed screening levels in various media onsite and are considered as PCOCs for OU1. VOC exceedances in soils and sediment were limited to one subsurface soil sample within the Monarch HRDL. One VOC groundwater exceedance occurred in 1993, but no exceedances were identified in the most recent sampling event. SVOC exceedances of screening levels in soils, sediments, and groundwater are generally collocated with PCBs in the same media. Inorganic constituents in soils, sediments, and seeps are also collocated with PCB exceedances of screening levels. Inorganic exceedances of screening levels in groundwater generally occur within areas where PCBs exceed soil screening levels, with the exception of the area along Portage Creek within the area the Former Bryant Mill Pond IRM. By addressing the PCB exceedances with the potential alternatives for OU1, the exceedances of VOCs, SVOCs, and inorganic constituents will also be addressed.

Tables 4-2E, 4-2G, 4-3E, 4-3G, 4-4C, and 4-4I of the RI report summarize the exceedances of VOCs, SVOCs, pesticides and inorganics in soils, sediments, groundwater, and seeps (Appendix D). Figures 4-2D, 4-2E, 4-2F, 4-3C, 4-3D, 4-3E, 4-4C, 4-4D, and 4-4J of the RI report present the information summarized in the tables (Appendix D).

1.6 Fate and Transport

In the final RI report, MDEQ identified the following PCB fate and transport mechanisms at OU1:

- PCB transport from surface water runoff and soil erosion
- PCB transport in groundwater
- PCB transport in Portage Creek
- PCB transport in air

The key exposure pathway of concern is the consumption of PCB-containing fish. As a result, the potential for bioaccumulation of PCBs from sediment into fish/biota tissue is of primary concern. The fate and transport mechanisms are briefly summarized in the following subsections, with the relevance of each mechanism to the development of the FS. The PCB fate and transport mechanisms are associated with secondary exposure pathways from contamination in residuals, soils, sediments, and groundwater. The remedial alternatives will be focused on addressing the source contamination.

1.6.1 PCBs in Residuals

In general, PCBs are chemically and thermally stable (Amend and Lederman 1992), fairly inert, have low solubility in water, and have a high affinity for solids making them strongly adhere to residuals. Typically, the lower the water solubility of a chemical, the more likely it is to be adsorbed onto solids. The degree of adsorption of PCBs in soils is a function of the soil organic content and the adsorption properties of the specific PCB compounds that are present. Other than organic content, soil or sediment characteristics that affect the mobility of PCBs include soil density, particle size distribution, moisture content, and permeability. Meteorological and physical conditions such as amount of precipitation and the presence of organic colloids (micron-sized particles) can also affect the mobility of PCBs in the environment (USEPA 1990). PCBs that are dissolved or sorbed to mobile particulates (for example, colloids) may also migrate with groundwater in sediments and soils.

The degree of adsorption of PCBs in soils is a function of the soil organic content and the adsorption properties of the specific PCB compounds that are present. Adsorption properties are generally characterized by an organic carbon partitioning coefficient, denoted as Koc. The Koc values for PCBs are relatively high (Chou and Griffin 1986), which means that PCBs readily adsorb to organic material in media such as sediments and soils.

The octanol water partitioning coefficient, denoted as Kow, is a measure of PCBs' solubility in water. The coefficient is the ratio of the concentration of PCBs in octanol over the concentration of PCBs in water. PCBs tend to have high Kow, indicating they are not very soluble in water. Taken together, the combination of low-water solubility and high Kow values indicates that PCBs have a strong affinity for soils and suspended solids, especially those high in total organic carbon (Chou and Griffin 1986).

The residuals present at OU1 are composed primarily of fibrous wood material and clay. PCBs have a high affinity for the residuals due to the high organic content. When compacted, the residuals have a low hydraulic conductivity. The hydraulic conductivity of 10 residuals samples collected from OU1 was approximately 1.3×10^{-7} centimeters per second (MDEQ 2008).

Based on the combined effects of high affinity for PCBs to adhere to the residual and the low hydraulic conductivity, it is understood that PCBs do not migrate significantly from the residual material. The finding is supported by the lesser extent of PCB detections in groundwater samples, approximately 13 percent, than in soil or sediment where PCBs are bound to the residual material.

1.6.2 Groundwater

The groundwater and seep samples collected during the 2002–2003 comprehensive sampling activity represent the most current data available to evaluate groundwater conditions. PCB detections associated with the 2002–2003 sampling include seeps and monitoring wells in areas that are located in the immediate vicinity of or in direct contact with PCB-containing residuals. Assessing the potential impact of PCB-containing residual to groundwater was a consideration in the development of potential remedial alternatives. PCBs were detected in only 13 percent of the 133 groundwater samples collected in 2002–2003. The 6 exceedances of GSI groundwater criteria occurred in wells screened within or immediately adjacent to the residuals. The 2002–2003 sampling of wells indicate that groundwater was not exceeding the GSI criteria prior to discharge to Portage Creek. This finding supports the assumption that PCB transport in groundwater is limited. Alternatives have been developed that minimize contact of groundwater with PCBs in soils and residuals.

1.6.3 Surface Water Runoff and Soil Erosion

The primary transport of PCBs in water is through PCBs adhered to particles, not the dissolution into groundwater as previously discussed. There are portions of OU1 (primarily in the Former Operational Areas) where PCBs and other PCOCs are present in surface soils and residuals. The materials may be transported to the floodplain or sediments in Portage Creek by erosion through the air or surface water runoff. Alternatives that prevent direct exposure of PCB-containing soils and residuals to air or surface runoff have been developed.

1.6.4 Direct Discharge

As described in the RI report, the most significant historical source of PCBs to Portage Creek from OU1 was the discharge of PCB-containing residuals at the Former Bryant Mill Pond (RI Section 5.5; MDEQ 2008). The excavation of PCB-containing sediments, residuals, and soils and subsequent replacement with clean fill in the Former Bryant Mill Pond has isolated the materials from direct contact with surface water, and removed the largest source of PCBs to Portage Creek at OU1. Under current conditions, the remaining potential sources of PCBs to Portage Creek from OU1 are primarily associated with the erosion of contaminated soils and sediments. The pathways are addressed in the development of remedial alternatives.

1.7 Supplemental Groundwater Study

In 2009, MHLLC completed a groundwater assessment to evaluate the potential for impacted groundwater at OU1 to migrate to the City's drinking water wells (ARCADIS 2009a). The first phase of the Supplemental Groundwater Study included an evaluation of existing data from OU1 and the nearby Strebor facility, and review of a groundwater flow model developed by the City (City of Kalamazoo 1999) to preliminarily evaluate the likelihood of a complete migration pathway from OU1 to the City's Central Wellfield. The assessment of existing data suggested that such a groundwater migration pathway to the City's Central Wellfield is unlikely. The assessment is based on the presence of a lateral aquitard beneath portions of OU1 and an upward vertical hydraulic gradient between the regional aquifer (used by the City for potable purposes) and the shallow aquifer.

The second phase of the study included the measurement and analysis of groundwater elevations obtained from wells located on OU1 and the Strebor, Panelyte, and Performance Paper properties to more quantitatively evaluate groundwater flow from OU1 offsite. The groundwater elevation data supported the conceptual understanding of the following:

- There is an upward gradient from the lower regional aquifer upward toward the surficial aquifer.
- Shallow groundwater flow from adjacent properties to the east and west is directed onto OU1.
- Portage Creek is the point of discharge from the surficial aquifer in OU1.
- A flow path from OU1 toward the City's Central Wellfield is unlikely.

Further empirical support for the conceptual understanding was provided by the analytical results for water samples collected by the City from its own production wells. There have been no detections of PCBs in the City's samples, even at trace levels.

The results of the supplemental groundwater investigation report provide a reasonable basis to determine that it does not appear there is a groundwater migration pathway from OU1 to the City's Central Wellfield. The complete report is included as Appendix A.

In a letter from MDEQ to USEPA on April 16, 2010, MDEQ stated that, in general, the MDEQ concurs with the following conclusions:

- Portage Creek appears to be the primary influence on the configuration of the water table surface within OU1. In the main disposal area of OU1, shallow groundwater discharges radially to Portage Creek.
- Shallow groundwater is influenced, although not completely captured, by the creek.
- Due to the upward pressure exerted by the groundwater present in the regional aquifer, the downward flow of groundwater from the surficial aquifer monitored at OU1 to the deeper regional aquifer is highly improbable.

Various data (collected over time) illustrate hydraulic disconnection between the surficial aquifer unit and the regional aquifer unit.

1.8 2011 Waste Characterization Sampling

Upon review of the RI sample results, it was determined that concentrations in residuals, soils, and sediments for lead, mercury, and chromium were of a level that could potentially exceed toxicity characteristic leaching procedure (TCLP) concentrations for characteristically hazardous waste. As a result, in July 2011, 8 samples were collected from locations with the highest historical concentrations of each analyte. The TCLP was run on each of the samples. None of the TCLP sample results exceeded the concentration for the material to be considered a characteristically hazardous waste (USEPA 2011).

1.9 Identification of Potential Contaminants of Concern

The RI report included a comparison of all detected concentrations of VOCs, SVOCs, pesticides, PCBs, and inorganics in residuals, soil, groundwater, groundwater seeps, sediments, and surface water to Act 451, Part 201, screening criteria. The screening criteria are conservative, risk-based values developed by MDEQ using generic exposure factors and scenarios. The outcome of the comparison against screening criteria was that PCBs, SVOCs, and inorganics were classified as PCOCs within soil/sediment at OU1, and PCBs and inorganic constituents were identified as PCOCs in groundwater. A comparison of PCOCs to chemical-specific ARARs is presented in Section 2. The comparison in Section 2 is used to develop the final list of COCs to be evaluated at OU1.

Tabular summaries of the screening evaluations for samples of soils, sediments, groundwater, and seeps at OU1 are presented in Appendix D. The locations where sample analytical results are above the screening criteria are summarized graphically in a series of figures in Appendix D.

1.9.1 PCBs

The investigation and cleanup work at OU1 over the past decade has been driven by the presence of PCBs and focused on mitigating potential risks posed by PCBs. For the purposes of the FS analyses, PCBs are PCOCs in soils, sediment, groundwater, and residuals. As described in Section 1.1 of the RI report, constituents other than PCBs have been detected in various media and are generally collocated with the PCBs. By remediating the PCBs, the exceedances of screening levels by other constituents are expected to be addressed.

1.9.2 Organic and Inorganic Constituents

Table 1-1 lists organic and inorganic contaminants by media that exceed Michigan Act 451, Part 201, screening criteria, which includes both risk-based and statewide background values in the RI. The contaminants listed are the PCOCs that have been used to define the areas associated with OU1 that require remediation.

The VOCs acetone and carbon tetrachloride were each detected in one sample at a concentration that exceeded the GSI protection screening criterion. Although not flagged, acetone is a common laboratory contaminant. The RI suggested VOCs detected in surface soils and sediments do not appear to be associated with OU1 activities. Based on the data evaluation in the RI report and frequency of detection, VOCs are not identified as PCOCs in any medium due to their infrequent detection above screening criteria.

The SVOC 4-methylphenol is found in several subsurface residuals samples at concentrations exceeding the GSI protection soil criteria. However, 4-methylphenol was not detected in any groundwater sample locations at concentrations exceeding GSI criteria. The SVOC 4-methylphenol is considered a PCOC at OU1 for residuals and soils. Since the distribution of 4-methylphenol is consistent with the distribution of PCBs, it is expected that addressing PCBs in soils, sediments, and residuals will also address the exceedances of 4-methylphenol.

The SVOCs acenaphthene (1 exceedance), carbazol (1 exceedance), naphthalene (2 exceedances), dibenzofuran (1 exceedance), pentachlorophenol (2 exceedances), and phenanthrene (1 exceedance) were detected in soils and residuals; however, due to the limited number of exceedances of the GSI criteria, the analytes may not be related to OU1 activities and are not considered PCOCs.

No exceedances of screening levels for TCL pesticides were noted in any media. Pesticides are not considered PCOCs.

TABLE 1-1
Summary of VOCs, SVOCs, Pesticides, PCDD/PCDF, and Inorganic Exceedances
OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Analyte	Surface Soils	Subsurface Soils	Surface Sediments	Subsurface Sediments	Groundwater[a]	Seeps[a]
VOCs						
Carbon Tetrachloride		1/54				
Acetone			1/2			
SVOCs						
Acenaphthene			1/2			
Carbazole			1/2			
Dibenzofuran			1/2			
Phenanthrene		1/54				
4-methylphenol		12/54				

TABLE 1-1

Summary of VOCs, SVOCs, Pesticides, PCDD/PCDF, and Inorganic Exceedances

OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Analyte	Surface Soils	Subsurface Soils	Surface Sediments	Subsurface Sediments	Groundwater[a]	Seeps[a]
Naphthalene		1/54	1/2			
Pentachlorophenol		1/54	1/2			
Pesticides						
None						
PCDD/PCDF[b]						
Total TCDD Equivalent	1/8					
Inorganics						
Aluminum	1/2	26/55			5/72	1/37
Antimony		7/55				
Arsenic	1/2	9/54	1/2		23/72	10/37
Barium		23/55	1/2	1/1	4/72	4/37
Cadmium		5/55				
Chromium	2/2	53/55	2/2	1/1	1/72	
Cobalt		6/55				
Copper		23/55		1/1		
Cyanide		21/54			4/72	3/37
Iron	1/2	8/55	1/2	1/1	64/72	31/37
Lead	1/2	20/55	1/2	1/1	1/72	
Magnesium		13/55				
Manganese		4/55			66/72	36/37
Mercury		20/55		1/1		
Nickel		1/55		1/1	4/72	1/37
Selenium		10/55	1/2	1/1		
Silver				1/1	2/72	
Sodium					4/72	
Vanadium					1/72	1/37
Zinc		28/45	1/2	1/1	7/72	

Note:
x/y = number of samples (x) exceeding screening level criteria out of number of samples (y)
[a] Only the data from the 2002–2003 groundwater and seep samples are summarized to reflect conditions after removal.
[b] Dioxin and furans only sampled in surface soils in 1998.
PCDD = polychlorinated dibenzodioxins, PCDF = polychlorinated dibenzofurans

Polychlorinated dibenzodioxin (PCDD)/polychlorinated dibenzofuran (PCDF) sampling was limited, with 8 surface soil samples collected in 1998 from the Former Operational Areas. Of the 8 samples, 1 sample exceeded the screening criteria. The screening criteria are the residential direct contact criteria. The sample did not exceed the non-residential direct contact criteria. The sample exceeding screening criteria is located within the Monarch HRDL. PCDD/PCDF are retained as PCOCs at OU1. It is expected that addressing PCBs in soils, sediments, and residuals will also address the exceedance of PCDD/PCDF or other areas where PCDD/PCDF could potentially be collocated with PCB impacts.

Silver (2 exceedances) and vanadium (1 exceedance) were analyzed in 72 groundwater samples. Additionally, silver exceeded the screening level criteria in the one subsurface soil sample analyzed and vanadium exceeded the screening-level criteria in 1 of the 37 seep samples analyzed. With a rate of exceedances less than 5 percent of the samples analyzed and no apparent relationship to the disposal of paper residuals, silver and vanadium are not considered PCOCs at OU1.

The elevated concentrations of zinc detected in certain groundwater samples may be related to well construction materials. Consistent with the findings of the RI report, zinc was detected at concentrations exceeding GSI criteria in samples of groundwater collected exclusively from pre-RI monitoring wells constructed with galvanized steel pipe risers. Conversely, none of the groundwater samples collected from monitoring wells constructed with stainless steel risers contained zinc at concentrations above GSI criteria. A review of the scientific literature indicates that zinc, iron, manganese, and cadmium are typical products of galvanized steel corrosion (Barcelona 1983; USEPA 1992a). However, based on the data screening evaluation, zinc also exceeded screening levels in 28 of 45 subsurface soil samples, and for this reason is retained as a PCOC in all medium.

1.10 Preliminary Remedial Goals

The investigation and cleanup work at OU1 over the past decade has been driven by the presence of PCBs and focused on mitigating the associated potential risks. As described in Section 1.9, SVOCs and inorganic constituents have been detected in various media and are also considered PCOCs for OU1 with PCBs. The PCOCs are generally collocated with the PCBs, so by remediating the PCBs, the exceedances of other PCOCs are expected to be addressed.

In March 2009, a technical memorandum (CH2M HILL 2009) was developed to assist in establishing a series of PCB PRGs for OU1. The PRGs were compiled after considering ongoing sources, release mechanisms, impacted media, potential exposure routes, and potential human and ecological receptors present at OU1. A series of quantitative PRGs and one qualitative PRG included in the March 2009 memorandum. The quantitative values are based on risk-based criteria described in the human health and ecological risk assessments developed for the site (CDM 2003a and 2003b) and other relevant risk-based regulatory criteria. The quantitative PRGs were developed based on the understanding that PCBs are the primary cause of human health and environmental risks at OU1. The March 2009 memorandum recommends a qualitative criteria, the visual identification of residuals, to assist in the determining if remedial action is required (CH2M HILL 2009).

The March 2009 memorandum includes an assessment of potentially complete exposure pathways and relevant receptors (CH2M HILL 2009). Of the pathways, the drinking water pathway was considered to be incomplete for OU1, since no drinking water wells are present onsite where PCB concentrations exceed criteria. The drinking water pathway is also considered incomplete for offsite receptors, since shallow groundwater primarily discharges to Portage Creek and a flow path toward the City Wellfield is unlikely. However, to protect against the future use of groundwater as drinking water, drinking water criteria are included in consideration of PRGs. The PRG memorandum recommends that remedial alternatives include institutional controls to prohibit the installation of drinking water wells on or adjacent to OU1 to prevent the completion of this pathway in the future. Since shallow groundwater primarily discharges to Portage Creek, the GSI criteria is included as a PRG. The PRG memorandum is in Appendix B for an initial analysis of criteria. Additional analysis was performed in the development of this FS as presented in Table 2-3.

Where available for contaminants other than PCBs, updated Act 451, Part 201, screening criteria and drinking water maximum contaminant levels will be used in the FS.

1.11 Conceptual Site Model

MDEQ completed a *Site-wide Final (Revised) Human Health Risk Assessment* (CDM 2003a) and *Final (Revised) Baseline Ecological Risk Assessment* (CDM 2003b) for the entire Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. The human health risk assessment quantitatively assessed potential risks to human health through exposure to media impacted with PCBs. The baseline ecological risk assessment quantitatively assessed potential risks to various ecological receptors for different exposure pathways. Risk to human and ecological receptors exists at the site based on the results of the human health risk assessment and baseline ecological risk assessment.

The primary exposure pathways at OU1 are associated with the following:

- Consumption of fish
- Direct contact with exposed materials with COCs above PRGs
- Inhalation of dust and volatile emissions from floodplain soils and consolidated residuals
- Ingestion of or direct contact with groundwater impacted above PRGs

Transport mechanisms that may result in completed exposure pathways include:

- Transport of groundwater impacted by contaminated material
- Surface water runoff
- Wind dispersion of exposed materials with COCs above PRGs
- Erosion of contaminated materials to Portage Creek and Kalamazoo River System

1.11.1 Soils and Sediments

OU1 was identified as a source of PCB contamination to Portage Creek, which flows to the Kalamazoo River. Soils and sediments containing residuals outside the existing cap have the potential for erosion to Portage Creek. The Monarch HRDL and portions of Type III Landfill are uncapped and adjacent to Portage Creek. During preparation of the RI, MDEQ developed a conceptual site model, which suggested that addressing PCB contamination in soils and sediments would also address PCBs in groundwater and other inorganic and organic contaminants that exceed screening levels.

Out of 60 inorganic sample locations and 59 organic soil, sediment, and residual sample locations, 10 locations had exceedances of GSI criteria for SVOCs and inorganics but did not exceed PCB criteria. The locations include: B-7B, DLHB-1, DLHB-2, DLHB-3, MA-1, MA-4, SP486, SP569, WA-3, and WA-5. Of the locations, DLHB-1, DLHB-2, DLHB-3, MA-1, MA-4, SP486, SP569, WA-3, and WA-5 are located within the Former Operations Area and are adjacent to locations where concentrations of PCBs exceeded criteria. Location B-7B is located on the western edge of OU1 in the Residential/Commercial area near the West Access Road. Location B-7B only had inorganics exceedances slightly above the screening criteria which were qualified results and do not appear to be related to OU1 activities.

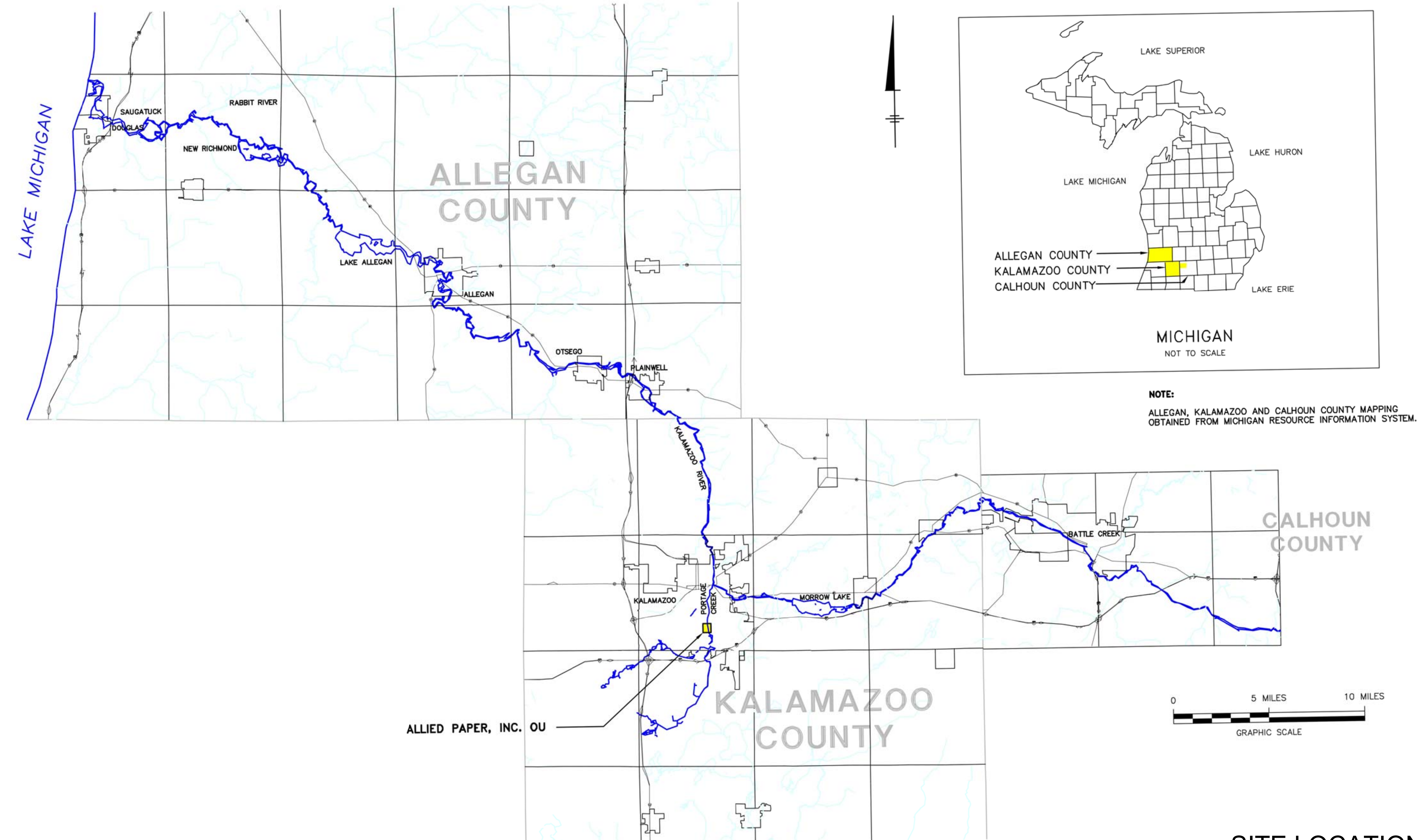
The TCRA and previous IRMs resulted in the consolidation of materials with elevated PCBs under the cap on the HRDLs and FRDLs. The integrity of the cap is currently uncertain and the potential exists for erosion of the existing cap. If the previously consolidated underlying soils and residuals are exposed, the materials could be transported to Portage Creek and the Kalamazoo River system.

1.11.2 Groundwater

The current evaluation of groundwater monitoring well and seep sampling results for locations that exceed screening levels support the conceptual site model assumption that addressing PCBs in soils and sediments will result in addressing other contaminants in groundwater. Information on the number of exceedances for each analyte is included in Table 1-1.

Monitoring well and seep locations that exceed organic and inorganic screening levels are identified in RI figures included in Appendix D. The locations are within, adjacent to, or downgradient of the Former Operations Area where PCB concentrations exceed screening levels. The results support the conceptual site model assumption that addressing PCBs in soils and sediments will result in addressing other contaminants in groundwater.

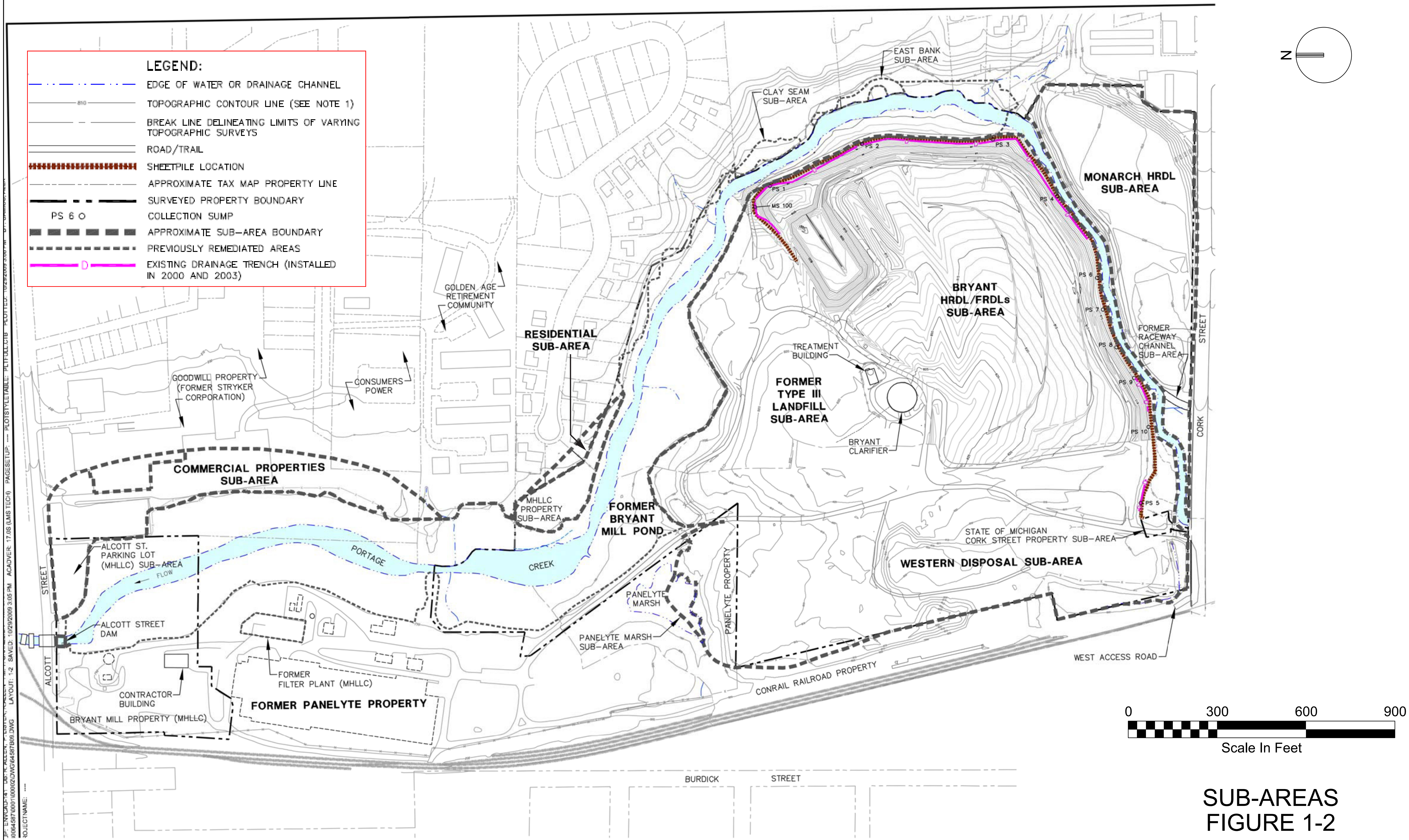
The alternatives presented within this FS were developed considering the conceptual site model.



SITE LOCATION
FIGURE 1-1

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

CH2MHILL

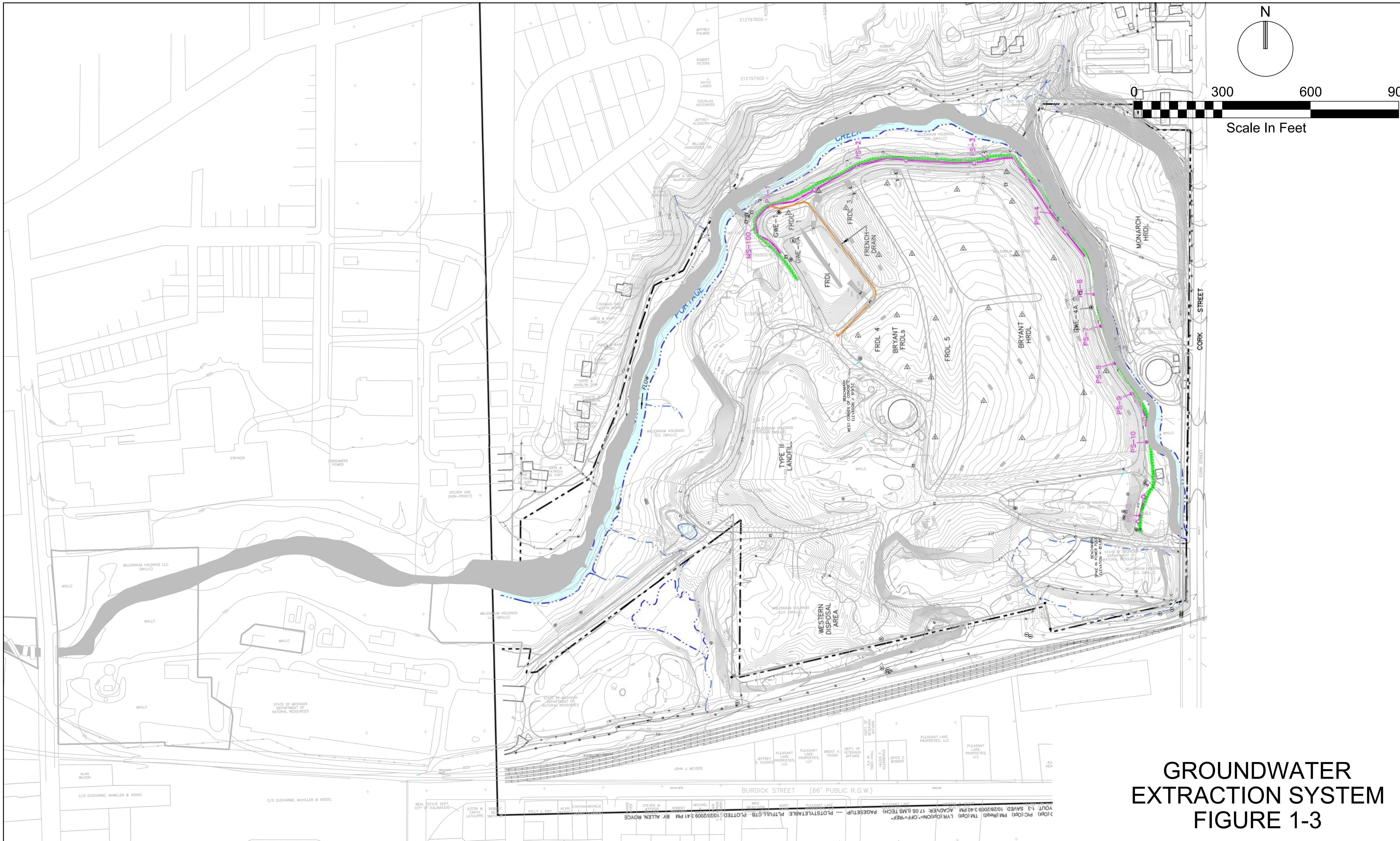


SUB-AREAS
FIGURE 1-2

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

CH2MHILL

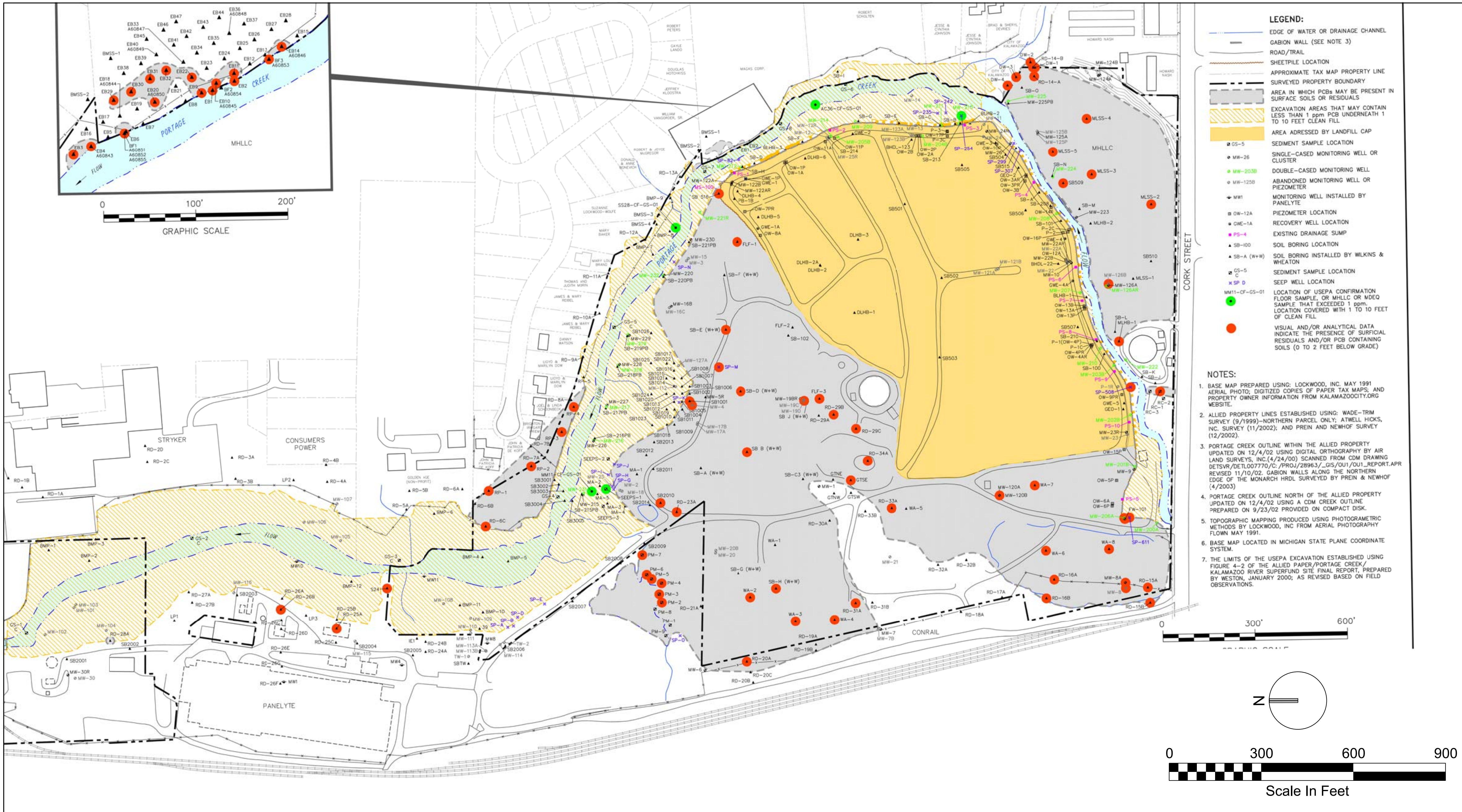


GROUNDWATER EXTRACTION SYSTEM
FIGURE 1-3

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

CH2MHILL

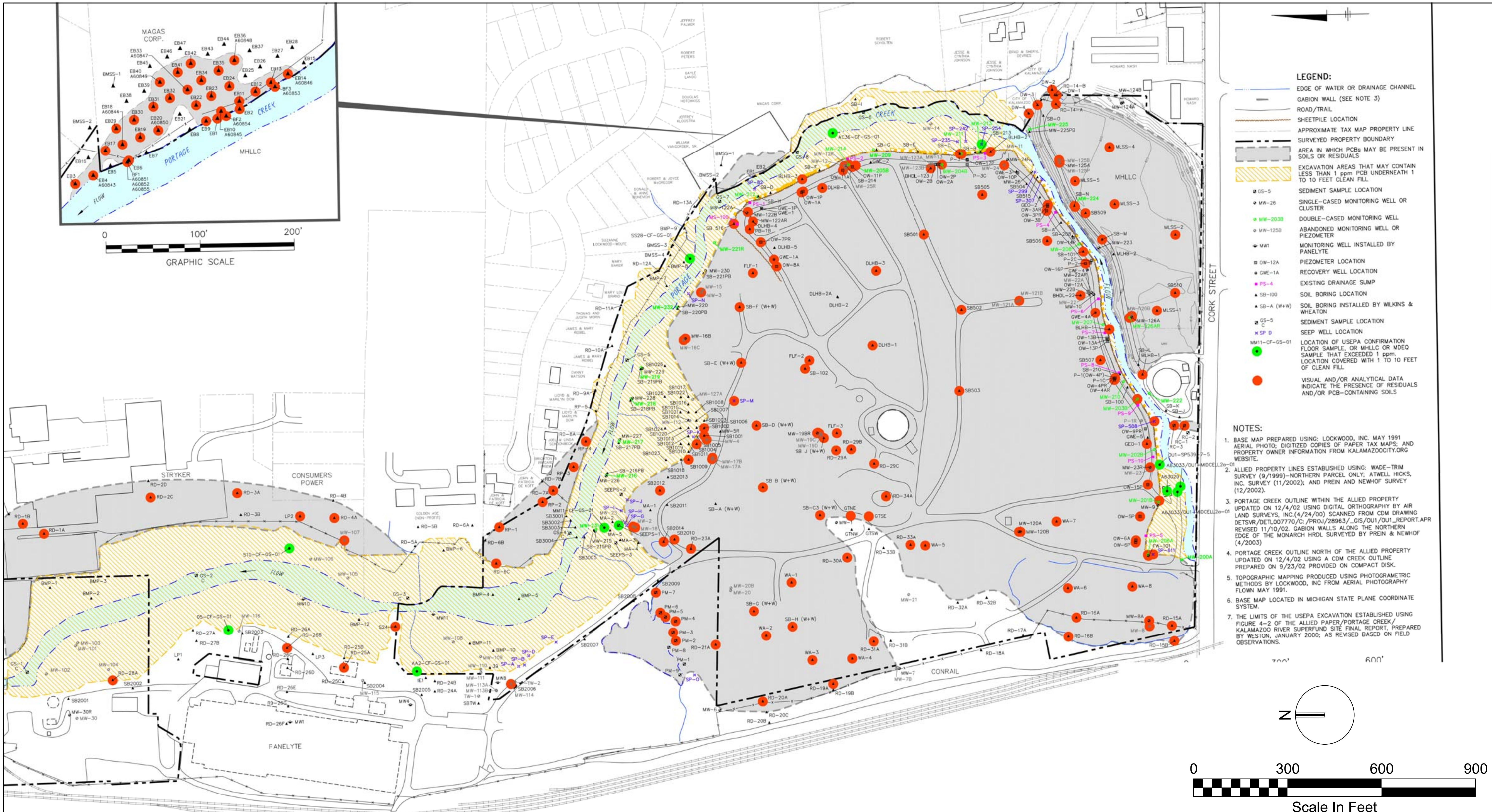


SURFICIAL EXTENT OF PCB
FIGURE 1-4

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

CH2MHILL



SURFACE / SUBSURFACE EXTENT OF PCB

FIGURE 1-5

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

CH2MHILL

SECTION 2

Development of Applicable or Relevant and Appropriate Requirements and Remedial Action Objectives

Section 2 identifies ARARs and RAOs and provides a list of GRAs for OU1.

2.1 Identification and Rationale for ARARs

CERCLA remedial actions must comply with other laws and regulations that are applicable or relevant and appropriate to the selected remedy. Applicable or relevant and appropriate requirements are referred to as ARARs. ARARs are federal and state public health and environmental requirements used to define the extent of site cleanup, identify sensitive land areas or land uses, develop remedial alternatives, and direct site remediation. ARARs are evaluated early in the work planning process so that fieldwork can be designed to collect data needed to satisfy ARAR requirements and, if necessary, to identify and evaluate remedial alternatives relative to ARARs.

Applicable requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances found at a CERCLA site (40 *Code of Federal Regulations* [CFR] § 300.4). Depending on the circumstance, hazardous substance, pollutant or contaminant, a state or federal environmental law or regulation may not be applicable but may be relevant and appropriate. Only the state standards that are identified in a timely manner and are more stringent than federal requirements may be applicable or relevant and appropriate (40 CFR § 300.400[g]). Section 121 of CERCLA requires that remedial alternatives that attain or exceed ARARs be primarily considered. To-be-considered factors are nonpromulgated advisories or guidance issued by the federal or state government that are not legally binding and do not have ARAR status. In many circumstances, such factors will be considered along with ARARs in determining the cleanup level required to protect human health and the environment.

ARARs are grouped into three types: chemical-specific, action-specific, and location-specific. The statutes and regulations listed in Table 2-1 contain requirements deemed to be potential ARARs at OU1 or to-be-considered factors. The ARARs are based on the preliminary list of possible ARARs included in the *Multi-Area Feasibility Study Technical Memorandum; Preliminary List of Possible Applicable or Relevant and Appropriate Requirements (*ARARs technical memorandum; ARCADIS 2009b). The most important ARARs are discussed in the following subsections.

2.1.1 Chemical-specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge.

2.1.1.1 Michigan Public Act 451, Part 201—Environmental Remediation

Part 201 establishes generic cleanup criteria for implementation of a remedial action or allows for risk-based determination of site-specific cleanup criteria. Where detection limits or background concentrations are greater than risk-based criteria, the detection limit or background concentration are used instead of the risk-based cleanup criteria. Part 201 also contains action-specific ARARs for OU1. Michigan Compiled Laws (MCL) 324.20114c requires land use or resource restrictions, including restrictive covenants, for remedial actions that do not satisfy cleanup criteria for unrestricted residential use. Also, MCL 324.20120e requires that a response action demonstrate compliance with groundwater/surface water requirements for groundwater venting to surface water.

2.1.1.2 Michigan Public Act 451, Part 31—Water Resources Protection

Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act (NREPA) establishes state criteria for rivers, creeks, and floodplain areas, to protect aquatic life and human health. It also establishes water quality standards and monitoring requirements for discharge effluents, including stormwater and venting groundwater, specifying standards for several water quality parameters, including COCs.

2.1.1.3 Clean Water Act Section 304

Under Section 304 of the Clean Water Act, USEPA has developed water quality criteria for (1) protection of human health, and (2) protection of aquatic life. See the discussion under Michigan Public Act (PA) 451 in Section 2.1.1.2 regarding protection of water quality criteria in Portage Creek.

2.1.2 Action-specific ARARs

Action-specific ARARs are activity- or technology-based, and they typically control remedial activities such as the generation or disposal of waste.

2.1.2.1 Clean Water Act

Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the United States, including the creek, floodplain, or wetlands. While CERCLA remedies are exempt from permit requirements, the substantive requirements of the implementing rules apply to the wetlands areas at the site. If any wetlands are filled, Superfund policy is to require a minimum of one acre of wetlands mitigation for each acre of wetland filled. (See "Considering Wetlands at CERCLA Sites" Office of Solid Waste and Emergency Response [OSWER] 9280.0-03.) The Federal Mitigation Rule is set forth at C*ompensatory Mitigation for Losses of Aquatic Resources; Final Rule* 40 CFR § 230.94(c)(2-14). In addition, the Clean Water Act applies to remediation alternatives, which treat and/or discharge water.

2.1.2.2 Toxic Substances Control Act

The principal contaminants of concern are PCBs. Under 40 CFR § 761.50(b)(3), PCB remediation waste is "regulated for cleanup and disposal in accordance with 40 CFR § 761.61." 40 CFR § 761.3 defines PCB remediation waste as "waste containing PCBs as a result of a spill, release, or other unauthorized disposal … at any concentration from a source not authorized for use under [the Toxic Substances Control Act (TSCA)]." PCB remediation waste includes "environmental media containing PCBs, such as soil and gravel, dredged materials, such as sediments, settled sediment fines, and aqueous decantate from sediment." 40 CFR § 761.61(a)(4) defines "bulk PCB remediation waste" to include "soil, sediments, dredged materials, muds, PCB sewage sludge, and industrial sludges." Specifically, TSCA regulations found at 40 CFR § 761.61(c) allows for a risk-based method for cleanup or disposal of PCB remediation waste when USEPA finds that that the method of disposal will not pose an unreasonable risk of injury to human health and the environment.

2.1.2.3 Resource Conservation and Recovery Act

Resource Conservation and Recovery Act (RCRA) regulations governing the identification, management, treatment, storage, and disposal of hazardous waste are applicable for hazardous waste if it is generated or identified during the remedial action.

Michigan is authorized to implement its RCRA program; therefore, the state laws and regulations arising out of that program constitute the ARARs instead of the federal authorizing legislation. The state's RCRA requirements apply to any response activities that generate waste material that may be classified as hazardous waste. However, hazardous waste is not present at the site based on existing data. Also, the state's hazardous waste landfilling, closure, and post-closure requirements are not applicable for onsite disposal because any material identified during the response action as RCRA hazardous waste will be disposed of offsite. RCRA hazardous waste generator requirements would be applicable if hazardous waste is identified at the site.

2.1.2.4 Michigan Public Act 451, Part 115—Solid Waste Management

The Part 115 rules promulgated for the cover design, groundwater monitoring, hydrogeologic monitoring, and construction quality control requirements for a Type III sanitary landfill would be relevant and appropriate for the alternatives that cap material in place at OU1.

2.1.2.5 River and Harbors Act

Section 10 prohibits the creation of obstructions to the capacity of, or excavation or fill within the limits of, the navigable waters of the United States. Typical requirements of dredging permits include measures to minimize re-suspension of sediments and erosion of sediments and stream banks during excavation.

2.1.3 Location-specific ARARs

Location-specific ARARs restrict the occurrence of chemicals in certain sensitive environments, such as wetlands.

2.1.3.1 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act requires that any action taken involves consideration of the effect that water-related projects would have on fish and wildlife, and that preventative actions are made to prevent loss or damage to the resources.

2.1.3.2 Executive Orders 11988 and 11990, and 50 CFR § 6 Appendix A

Executive Orders (EOs) 11988 (Floodplain Management) and 11990 (Protection of Wetlands) are to-be-considered factors. They set forth USEPA policy for carrying out the provisions of EOs 11988 and 11990. EO 11988 requires that actions be taken to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. EO 11990 requires that actions at the site be conducted in ways that minimize the destruction, loss, or degradation of wetlands.

2.2 Remedial Action Objectives

RAOs are goals specific to media or OUs for protecting human health and the environment. Risk can be associated with current or potential future exposures. RAOs should be as specific as possible without unnecessarily limiting the range of alternatives to be developed. Objectives aimed at protecting human health and the environment should specify the following: (1) COCs, (2) exposure routes and receptors, and (3) an acceptable contaminant level or range of levels for each exposure route (that is, a PRG) (USEPA 1988).

RAOs were developed for OU1 in part based on the contaminant levels and exposure pathways found to present potentially unacceptable risk to human health as determined during the RI (MDEQ 2008) and in the PRG memorandum (Appendix B). PRGs were then developed based on the potential exposure pathways, risk assessments (CDM 2003a and b), and state ARARs. The RAOs, remediation goals, remediation strategies, and alternatives developed in Section 4 of this report address unacceptable risks at the site. Table 2-2 presents the RAOs.

TABLE 2-2
Remedial Action Objectives
OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

RAO 1	Mitigate the potential for human and ecological exposure to materials at OU1 containing COC concentrations that exceed applicable risk-based cleanup criteria.
RAO 2	Mitigate the potential for COC-containing materials to migrate, by erosion or surface water runoff, into Portage Creek or onto adjacent properties.
RAO 3	Prevent contaminated waste material at the OU1 landfill from impacting groundwater and surface water.

In addition to the RAOs, the public has requested that the footprint of the landfills be reduced. The objective will be evaluated as part of the evaluation against USEPA’s nine criteria.

2.3 Preliminary Remediation Goals

In general, PRGs provide remedial staff with criteria to use during analysis and selection of remedial alternatives. Chemical-specific PRGs are concentration goals for individual chemicals for specific medium and land use combination at CERCLA sites. Promulgated cleanup levels and risk-based concentrations are considered in developing PRGs.

2.3.1 PCBs

The PCB data representative of current conditions were compared with the PRGs to identify the media and volume within specific subareas of OU1 to be addressed by remediation. For the purpose of the FS, the lowest applicable criterion was applied to an area. For example, the criteria of 1.0 mg/kg residential and 0.33 mg/kg surface sediment criteria protective of fish would both apply to surface sediments in a residential area. In this case, the lower criterion (0.33 mg/kg) was used to define the extent of remediation. In the instances where the detection limit is greater than the risk criterion, the detection limit is used.

Table 2-3 presents the OU1 PRGs for PCBs.

TABLE 2-3
Summary of Preliminary Remedial Goals Established by USEPA for PCBs
OU1 Feasibility Study Report—Allied Paper, Inc./ Portage Creek/Kalamazoo River Superfund Site

Medium	Pathway		PCB PRG	Basis
Soils	Human Health	Residential	1.0 mg/kg[a]	40 CFR § 761.61(a)(4)
		Non-Residential	10 mg/kg[b]	40 CFR § 761.61(a)(4)
		Recreational	23 mg/kg[c]	HHRA
	Ecological	Aquatic	0.5–0.6 mg/kg	BERA
		Terrestrial	6.5–8.1 mg/kg	BERA
Subsurface Soils	Human Health	Residential	1.0 mg/kg[a]	40 CFR § 761.61(a)(4)
		Non-Residential	10 mg/kg[b]	40 CFR § 761.61(a)(4)
Surface and Subsurface Sediments	Human Health	Recreational	23 mg/kg[c]	HHRA
		Terrestrial	6.5–8.1 mg/kg	BERA
		Fish Consumption	0.33 mg/kg[c,d]	HHRA
	Ecological	Aquatic	0.5–0.6 mg/kg	BERA
Groundwater (including seeps)	Human Health	Direct Contact	3.3 µg/L[e]	MI Part 201 direct contact criteria
		Groundwater-Surface Water Interface (GSI)	0.2 µg/L[f]	MI Part 201 GSI criteria
Residuals	N/A	Qualitative: Where a removal is proposed, all visible residuals are to be removed unless analytical data are available to confirm PCBs (if present) are below applicable criteria.		

Notes:
[a] Based on high-occupancy cleanup level (without conditions) set forth in 40 CFR § 761.61(a)(4).
[b] Based on 40 CFR § 761.61(a)(4) with restrictive covenant prohibiting high occupancy use.
[c] Based on recreational exposure as developed in HHRA.
[d] Default sediment criteria of 0.33 mg/kg will be applied to shallow soil in areas of periodic inundation due to the potential runoff of shallow soils into surface water. Evaluation of contaminated soil runoff to surface water required under R299.5728(f).
[e] Groundwater for use as drinking water is not considered a complete pathway so the Part 201 Drinking Water criteria of 0.5 microgram per liter (µg/L) was not used. The Part 201 direct contact criteria were used for protection of human health due to the presence of seeps.
[f] The groundwater criteria protective of surface water is a PRG where the GSI is present (MCL 324.20120e and Part 31).
BERA = baseline ecological risk assessment; HHRA = human health risk assessment; mg/kg = milligrams per kilogram;
N/A = not applicable
Source: CH2M HILL 2009

2.3.2 Contaminants of Concern

PCOCs are shown in Table 1-1. PCOCs were further evaluated against the PRG criteria and background concentrations to determine final COCs to be evaluated at OU1. The COCs retained for OU1, in addition to PCBs, are provided in Table 2-4. The highlighted values in Table 2-4 represent the lowest PRG criteria for each contaminant unless background is higher. If background is higher than the PRG criteria, the background value is used.

For this FS report, OU1 subareas described in Section 1.2 were evaluated based on media (for example, soil or sediment) and, as appropriate, current land use and zoning (for example, residential, commercial, or manufacturing; a current land use and zoning map is included in Appendix C). Figure 2-1 depicts the subareas where PRGs are not currently being achieved and are classified according to PRGs and land use.

The volumes of residuals, soils, or sediments that are present at OU1 with PCB concentrations above the relevant PRGs were estimated for each subarea. During the RI work, soil borings were sampled to characterize the vertical and horizontal extent of PCBs within OU1 and adjacent areas. Soil borings sampled during the RI work to determine the horizontal and vertical extent of PCB contamination in conjunction with field observations of extent and thickness of “gray clay” material and analytical data were used to estimate the volume of soils, residuals, and sediments in various areas of OU1 where PCBs exist at concentrations above the PRGs (Table 2-5). Note that the volumes in Table 2-5 are not targeted removal volumes. Removal volume estimates are developed for specific remedial alternatives presented in Section 4.

TABLE 2-4

Summary of Preliminary Remedial Goals by USEPA for COCs

OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek / Kalamazoo River Superfund Site

	Residential Soils/Sediments (µg/kg)				Groundwater (µg/L) and Seeps[a]	
Analyte	**Statewide Default Background Level**	**Residential Drinking Water Protection Criteria & RBSLs**	**Groundwater Surface Water Interface Protection Criteria and RBSLs**	**Direct Contact Criteria & RBSLs**	**Residential Drinking Water Criteria & RBSLs**	**Groundwater Surface Water Interface Criteria & RBSL**
SVOCs						
4-methylphenol	N/A	7,400	1,000	11,000,000	370	30
PCDD/PCDF[b]						
Total TCDD Equivalent[d]		NLL	NLL	0.09	N/A	
Inorganics						
Aluminum (B)	6,900,000	6,000,000	N/A	50,000,000	50	N/A
Antimony	N/A	4,300	94,000	180,000	6	130
Arsenic	5,800	4,600	4,600	7,600	10	10
Barium (B)	75,000[c]	1,300,000	660,000 (G)	37,000,000	2,000	1,000 (G)
Cadmium (B)	1,200[c]	6,000	3,000 (G)	550,000	5	2.5 (G)
Chromium	N/A	30,000	3,300	2,500,000	100	11
Cobalt	6,800	800	2,000	2,600,000	40	100
Copper	32,000[c]	5,800,000	100,000 (G)	20,000,000	1,000	18 (G)
Cyanide	390	4,000	100	12,000	200	5.2
Iron (B)	12,000,000	6,000	N/A	160,000,000	300 (E)	N/A
Lead (B)	21,000[c]	700,000	2,500,000 (G)	400,000	4	14 (G)
Magnesium (B)	N/A	8,000,000	N/A	1,000,000,000	400,000	N/A
Manganese (B)	440,000	1,000	26,000 (G)	25,000,000	50	1,300 (G)
Mercury	130	1,700	50	160,000	2	0.0013
Nickel	20,000 [c]	100,000	100,000 (G)	40,000,000	100	100 (G)

TABLE 2-4

Summary of Preliminary Remedial Goals by USEPA for COCs

OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek / Kalamazoo River Superfund Site

	Residential Soils/Sediments (µg/kg)				Groundwater (µg/L) and Seeps[a]	
Analyte	Statewide Default Background Level	Residential Drinking Water Protection Criteria & RBSLs	Groundwater Surface Water Interface Protection Criteria and RBSLs	Direct Contact Criteria & RBSLs	Residential Drinking Water Criteria & RBSLs	Groundwater Surface Water Interface Criteria & RBSL
Selenium	410	4,000	400	2,600,000	50	5
Zinc	47,000[c]	2,400,000	230,000 (G)	170,000,000	2,400	235 (G)

[a]Only the data from the 2002–2003 groundwater and seep samples are summarized to reflect conditions after removal.

[b]Dioxin and furans were only sampled in 1998.

[c]Background value used in RI as screening criteria, lowest risk-based level highlighted used for COC comparison.

µg/kg = micrograms per kilogram; N/A = not applicable; NLL = not likely to leach; RBSL = risk-based screening level

(B) = Background, as defined in R 299.5701(b), may be substituted if higher than the calculated cleanup criterion.

(E) = Criterion is the aesthetic drinking water value, as required by Section 20120a(5) of the NREPA 1994 Public Act (PA) 451, as amended by the NREPA of 1994

(G) = Calculated value dependent on pH, hardness

Highlighted cells = lowest applicable criteria

Source: Non-residential Part 201 Generic Cleanup Criteria and Screening Levels; Part 213 Tier 1 Risk-based Screening Levels, document release date March 25, 2011.

TABLE 2-5

Media of Concern, Zoning Classification, and Estimated Volumes of PCB-containing Soils and Sediments Exceeding PRGs

OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

Subarea	Media of Concern	Zoning Classification	Estimated Volume (yd^3)[a]	Estimated Area (acres)[a]
Former Operational Areas				
Monarch HRDL				
HRDL Disposal Area[b]	Soils, groundwater	Manufacturing	170,000	6.8
Former Raceway Channel	Sediments		Less than 100	Less than 0.1
Former Type III Landfill[c]	Soils, groundwater	Manufacturing	405,000	13.6
Western Disposal Area				
Disposal Area[d]	Soils, groundwater	Manufacturing	270,000	13.2
Panelyte Property (southern end)	Soils		4,000	1.4
Panelyte Marsh	Sediments		300	0.9
Conrail Property	Soils		Less than 100	0.1
State of Michigan Cork Street Property	Soils		TBD[g]	TBD[g]
Bryant HRDLs/FRDLs[e]	Soils, groundwater	Manufacturing	635,000	22.1
Outlying Areas[f]				
Residential Area				
Golden Age Retirement Community	Soils	Residential	1,100	Less than 0.1
Single-Family Residences		Residential	2,100	0.3
Lyondell Trust (formerly MHLLC)-owned property		Manufacturing	7,700	1.1
Commercial Properties				
Goodwill lawn	Soils	Manufacturing	28,500	1.7
Goodwill parking lots			38,500	2.3
Goodwill beneath buildings			8,500	0.5
Consumers Power			1,100	Less than 0.1
Lyondell Trust (formerly MHLLC) Alcott Street Parking Lot			12,000	0.7
Filter Plant			TBD[g]	TBD[g]
Bryant Mill Property			TBD[g]	TBD[g]

[a]All estimated volumes and areas are approximate. All areas and volumes are based on known or suspected presence of PCBs at any concentration. Volumes and areas will be refined during the predesign investigation to identify the extents of PCB impacts above PRGs.

[b]Monarch HRDL: The estimated area represents the total area of PCB-containing soils. Of the 6.8 acres, it is estimated that approximately 6 acres (135,000 yd^3) would be capped under a containment scenario, and that approximately 0.8 acre (35,000 yd^3) would comprise the remaining peripheral area.

[c]Former Type III Landfill: The estimated area represents the total area of PCB-containing soils. Of the 13.6 acres, it is estimated that approximately 10 acres (approximately 245,000 yd^3) would be capped under a containment scenario, and that approximately 3.6 acres (approximately 160,000 yd^3) would comprise the peripheral area.

[d]Western Disposal Area: The estimated area represents the total area of PCB-containing soils. Of the 13.2 acres, it is estimated that approximately 12 acres (245,000 yd^3) would be capped under a containment scenario, and that approximately 1.2 acres (25,000 yd^3) would comprise the peripheral area.

[e]Bryant HRDLs/FRDLs: The estimated volume associated with the Bryant HRDLs/FRDLs represents the volume of PCB-containing soil, not the total volume of soil. The total volume of soil associated with this area is approximately 725,000 yd^3, which includes approximately 90,000 yd^3 of clean soil cover.

[f]The volumes of PCB-containing soils within the Residential and Commercial Properties may be further refined based on additional delineation activities.

[g]TBD limited information is available. A predesign field investigation will be required to define the extent of contamination if present.

2.4 Redevelopment

OU1 lies within the Portage Creek Corridor. The City of Kalamazoo has developed plans for redevelopment of the land adjacent to Portage Creek. Goals of the plan include the following:

- Increasing the amount of land available for commercial and manufacturing use
- Creating a walking path parallel to Portage Creek
- Creating public open space

The remedial alternatives were developed to meet the RAOs, but may allow some or all of the redevelopment goals to be met. Discussion of remedial alternatives in Section 5 will include an evaluation of the redevelopment goals as presented in the plan.

2.5 General Response Actions

GRAs were identified after action-specific ARARs and remedial actions used, or considered for use, at similar sites were considered and reviewed. GRAs do not explicitly identify specific processes or materials to be used, but rather generic technology types that could be used individually or in combination.

The following GRAs can be applied to the RAOs for soils, sediment, and groundwater at OU1:

A. *No Action:* A baseline alternative was evaluated because it is required by CERCLA; however, the no-action alternative does not achieve the RAOs.

B. *Institutional Controls:* Implement administrative controls or legal requirements that help to minimize the potential for human or ecological exposure to contamination and protect the integrity of the remedy.

C. *Monitoring:* Monitor remedy performance through groundwater, landfill gas, and physical structures to identify areas of noncompliance.

D. *Monitored Natural Attenuation:* Reduce the bioavailability of PCBs over time through natural processes, and monitor the performance of those processes as compared with expected results.

E. *In Situ Containment:* Consolidate onsite soils and sediments in an engineered disposal area at OU1, apply a fully encapsulated landfill containment, implement erosion controls, and implement hydraulic modifications.

F. *In Situ Treatment:* Treat in-place soil and sediment to reduce mobility, toxicity, or volume.

G. *Removal:* Excavate soil and sediment, and collect and treat groundwater.

H. *Ex Situ Treatment:*

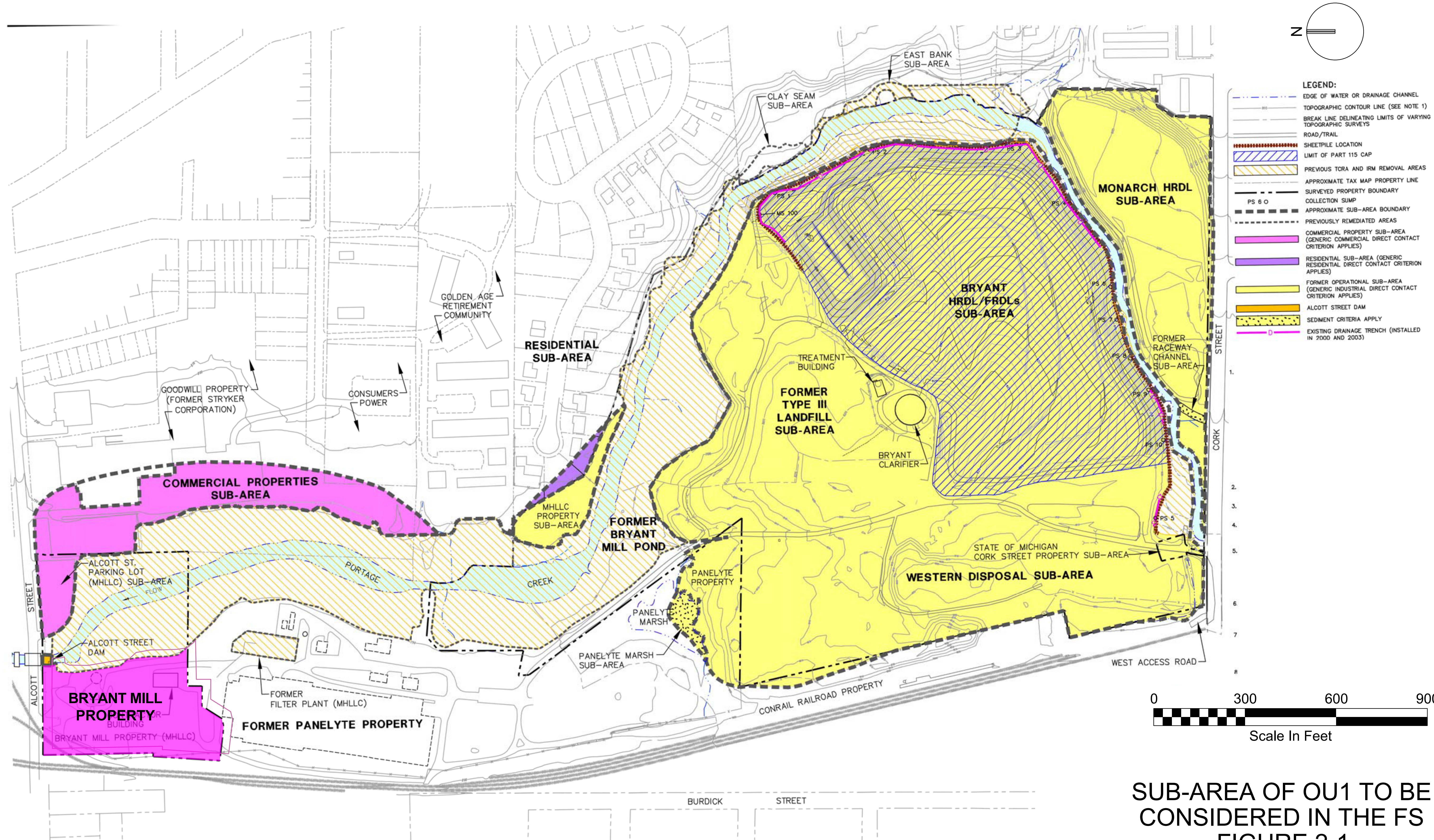
   – Employ water treatment technologies (for example, activated carbon) to reduce the volume, mobility, and concentrations of PCBs in water prior to discharge to the Portage Creek.

   – Treat soil and/or sediment at an offsite permitted treatment facility to reduce PCB volume, mobility, and concentrations.

I. *Transportation and Disposal:*

   – Transport offsite soil and sediment to a permitted landfill facility for disposal. (The type of facility would be selected based on the PCB concentrations in the materials to be disposed. Materials with PCB concentrations equal to or above 50 mg/kg are required to be disposed in a TSCA-regulated landfill, while materials with PCB concentrations below 50 mg/kg are disposed of in solid waste landfills.)

   – Consolidate materials excavated into onsite locations designated as a landfill.



SUB-AREA OF OU1 TO BE CONSIDERED IN THE FS

FIGURE 2-1

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

CH2MHILL

SECTION 3

Identification and Evaluation of Technologies

A range of potentially applicable remedial technologies and process options were identified and evaluated against the RAOs for OU1. In accordance with USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988), the identified technologies were evaluated in two steps. First, an array of possible remedial technologies was evaluated based on the potential for technical implementability at OU1. The evaluation was based on the PCB data gathered during the RI, the media of concern, and the specific characteristics of OU1. Technologies that cannot be feasibly implemented were eliminated. Next, the remaining technologies were further evaluated based on overall effectiveness, implementability, and relative cost. Representative technologies retained following this screening step were then assembled into a range of potential remedial alternatives. The process is described in more detail in the following subsections.

3.1 Identification and Screening of Remedial Technologies and Process Options

A variety of potential technologies and process options associated with each GRA were compiled based on OU1-specific GRAs defined in Section 2.5. Remedial technologies are considered as general categories of technologies, while process options refer to specific processes within each technology type (USEPA 1988). For example, erosion control is a specific remedial technology in the more general in situ containment GRA, and sheet pile wall installation is a process option under erosion control.

Remedial technologies and process options were first evaluated based on their technical implementability at OU1. The general evaluation of the technical implementability considered three factors: (1) whether the remedial technology or process option is applicable with respect to specific OU1 conditions, (2) whether implementation is feasible, and (3) whether the technology has been fully developed for use. The analysis is based on prior knowledge of the conditions at OU1 and the site, information from other similar sites, and scientific literature. The initial screening step was conducted to reduce the number of potential remedial technologies that were to be evaluated more rigorously. Only process options and entire technology types that could be effectively implemented at OU1 were carried forward to the next step.

Table 3-1 identifies GRAs and screens potential remedial technologies and process options that could reasonably be applied to soils, sediments, and groundwater at OU1. The table also identifies the media to which the option might apply and a preliminary assessment of technical implementability. Process options that did not meet the technical implementability criteria as described above were eliminated from further evaluation.

In some cases, only one representative process option was carried forward for further evaluation (Table 3-1). Selecting specific representative process options is intended to streamline the development of potential remedial alternatives. An eliminated process option could still be considered during remedial design if its technology type was part of the selected remedial alternative.

The approach is in accordance with USEPA guidance (1988), which states the following:

> *One representative process is selected, if possible, for each technology type to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. The representative process provides a basis for developing performance specifications during preliminary design; however, the specific process actually used to implement the remedial action at a site may not be selected until the remedial design phase.*

For example, in the transportation remedial technology, while both rail and truck transport are feasible approaches, only truck transport was retained as the representative process option and carried through for further analysis. If offsite disposal is selected as the remedial alternative, then rail transport might be further considered.

3.2 Evaluation of Process Options

The next step of the remedial technologies screening process is to further evaluate the remedial process options retained at the end of the first step (Table 3-1). Within each remaining GRA, remedial technologies were identified and screened based on effectiveness, implementability, and relative cost. The criteria are defined as follows:

- **Effectiveness** is the ability of the technology or process option to perform adequately to achieve the remedial objectives alone or as part of an overall system. It may be considered as a function of long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, or short-term effectiveness.
- **Implementability** refers to degree of difficulty expected in putting into place a particular measure under practical technical, regulatory, and schedule constraints.
- **Relative cost** is comparative only and is judged similar to the effectiveness criterion. It is used to preclude further evaluation of process options that are very costly where there are other choices that perform similar functions with comparable effectiveness. It includes construction and long-term operation and maintenance (O&M) costs.

Table 3-2 presents the results of the second screening phase in terms of effectiveness, implementability, and cost. Representative process options for each technology type were retained for incorporation into the range of potential remedial alternatives based on the two-step evaluation and technology screening process. Consistent with state and federal guidance, the No Further Action GRA was retained as a baseline against which other remedial alternatives will be evaluated.

Process options were eliminated during this second screening step if the option met any of the following criteria:

1. It did not effectively meet the RAOs established in Section 2.2.
2. It was not applicable to PCBs, conditions at OU1, or the media of concern.
3. It was not sufficiently demonstrated at pilot-scale or full-scale.
4. It was similar to other retained options but had a much higher relative implementation cost.

Each eliminated process option is shaded in Table 3-2, and the following briefly describes the elimination rationale:

- **Ex Situ Treatment—Basic Extractive Sludge Treatment:** This option was not retained based on the following:
  - Reduction of toxicity, mobility, or volume through treatment—This approach has not been shown to effectively treat PCBs in paper-making residuals to meet goals.
  - Implementability—Limitations based on scale of OU1 and quantity of PCB-containing materials subject to treatment.
- **In Situ Treatment—Solidification:** This option was eliminated based on the following:
  - Reduction of toxicity, mobility, or volume through treatment—Little or no gain achieved in immobilization over current conditions due to PCBs affinity for residual materials.
  - Reduction of toxicity, mobility, or volume through treatment—No reduction in hydraulic conductivity of waste material. Waste has hydraulic conductivity of 1×10^{-7} centimeters per second, lower than what is sometimes achieved by solidification.
  - Reduction of toxicity, mobility, or volume through treatment—Significant increases in the volume of waste occur due to the addition of the solidifying agent. Increases can be in the range of 15 percent or more.
  - Does not eliminate the need for a cover to protect against direct contact of waste material.

3.3 Assembly of Alternatives

Table 3-3 summarizes the response actions by subarea.

The alternatives assembled from the retained process options are listed below. Section 4 describes each alternative in detail, and Sections 5 and 6 evaluate them with respect to the relevant CERCLA criteria.

- Alternative 1—No Further Action
- Alternative 2—Consolidation and Capping

  a. Consolidate Outlying Areas on the Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Areas with the following steps:
     - Excavate Outlying Areas
     - Excavate and pull back perimeter around Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Areas
     - Pull back Monarch HRDL
     - Consolidate excavated material on the Bryant HRDL/FRDL , Former Type III Landfill, and Western Disposal Areas
     - Install cap on Bryant HRDL/FRDL, Former Type III Landfill, Western Disposal Areas, and Monarch HRDL
     - Implement restrictive covenant to limit use in commercial areas
     - Implement restrictive covenant to prohibit interference with the structures, caps, and fences
     - Implement restrictive covenant to prohibit groundwater use
     - Restore wetlands and implement restrictive covenant to maintain wetland areas.
     - Monitor groundwater to verify effectiveness

  b. Consolidate Outlying Areas and Monarch HRDL on Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Areas with the following steps:
     - Excavate Outlying Areas
     - Excavate Monarch HRDL
     - Excavate and pull back perimeter around Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Area
     - Consolidate excavated material on the Bryant HRDL/FRDL , Former Type III Landfill, and Western Disposal Areas
     - Install cap on Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Area
     - Implement restrictive covenant to limit use in commercial areas
     - Implement restrictive covenant in capped areas to prohibit interference with the cap and fences and to prohibit groundwater use
     - Restore wetlands and implement restrictive covenant to maintain wetland areas.
     - Monitor groundwater to verify effectiveness

  c. Consolidate materials from Outlying Areas and Monarch HRDL with a PCB concentration of 500 mg/kg or less on Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Areas and offsite incineration of soils/sediment with PCB concentrations above 500 mg/kg with the following steps:
     - Excavate Outlying Areas
     - Excavate Monarch HRDL
     - Excavate and pull back perimeter around Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Area

- Offsite incineration of material with PCB concentration s above 500 mg/kg
- Consolidate materials with PCB concentrations of 500 mg/kg or less on Bryant HRDL/FRDL, Former Type III Landfill and Western Disposal Area
- Install cap on Bryant HRDL/FRDL, Former Type III Landfill, and Western Disposal Area
- Restore wetlands and implement restrictive covenant to maintain wetland areas
- Implement institutional controls, where necessary
- Monitor groundwater to verify effectiveness

d. Employ groundwater options

- Optional—groundwater hydraulic control and treatment
- Optional—slurry cut-off wall with hydraulic control and treatment

- Alternative 3—Total Removal and Offsite Disposal
  - Excavate Outlying Areas and Operational Areas
  - Transport materials above PRGs offsite for disposal
  - Backfill the excavation to above water table elevations in Operational Areas and to original grade in the Outlying Areas
  - Implement restrictive covenant to limit use in commercial areas
- Alternative 4—Encapsulation Containment System
  - Excavate Outlying and Operational Areas and stockpile
  - Line bottom of OU1
  - Place consolidated material within the lined OU1 area
  - Install cap
  - Implement restrictive covenant to limit use in commercial areas
  - Implement restrictive covenant in capped areas to prohibit interference with the cap and fences and to prohibit groundwater use
  - Restore wetlands and implement restrictive covenant to maintain wetland areas.
  - Monitor groundwater to verify effectiveness

Groundwater monitoring is included in all of the alternatives that leave waste in place or consolidated onsite. Monitoring will include up- and downgradient wells to determine if COCs are migrating offsite. For Alternative 2 options, the following two subalternatives will be considered as noted above:

- Subalternative (i)—Groundwater collection and treatment, which includes a system of extraction wells or trenches installed downgradient to capture groundwater before discharge to Portage Creek.
- Subalternative (ii)—Slurry wall installed downgradient of groundwater flow along with extraction wells or trenches to prevent groundwater mounding behind the slurry wall.

The City of Kalamazoo requested that USEPA consider a slurry wall that fully encompasses the landfills. The evaluation of a slurry wall has been included; however, under subalternative (ii), the wall would be constructed only downgradient of the landfill, which provides a similar level of protection for Portage Creek, mitigates the potential for affecting adjacent property owners upgradient of the wall, and reduces the cost of the wall by half.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
A. No Further Action				
	No Further Action	The "no action" technology includes ongoing natural attenuation of PCBs in soils and sediments, but would not require any engineering or institutional controls to mitigate exposure, or monitoring to assess ongoing contact with constituents of concern, and as such serves as a baseline for comparison to all other remedial technologies. Inclusion of this technology is required by the National Contingency Plan.	Soils*, sediments, and groundwater	Implementable.
B. Institutional Controls				
	Access Restrictions, Deed Restrictions, and Fish-Consumption Advisories	Institutional controls (ICs) are non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. Examples of potential ICs include proprietary controls (e.g., easements, covenants), governmental controls (e.g., zoning, building codes, groundwater use regulations), enforcement and permit tools with IC components (e.g., orders, permits, consent decrees), or informational devices (e.g., state registries, fishing advisories, signs).	Soils, sediments, and groundwater	Implementable; access restrictions, deed restrictions, and fish-consumption advisories, are already in place in some areas.
C. Monitoring				
	Monitoring	Monitoring would involve the collection and analysis of site samples (e.g., soil, sediment and/or groundwater) and/or performance of visual reconnaissance (inspections) to track site conditions.	Soils, sediments, and groundwater	Implementable.
D. Monitored Natural Attenuation				
	Natural Processes	The effects of ongoing physical, biological, and chemical processes that reduce PCB exposure, toxicity, and mobility would be monitored to verify decreasing concentration trends. The persistence and immobility of PCBs do not support natural degradation of PCBs in soil or groundwater.	Soils, sediments, and groundwater	Implementable, though unproven for PCBs in soils and groundwater.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
E. Containment				
1. Engineered Barrier	Engineered Landfill Cap (Earthen Cover)	This Process Option includes the grading in place and placement of clean earthen material directly over affected soils/sediments.	Soils, sediments	Implementable; equipment, materials, and labor readily available, would not reduce infiltration to prevent the formation of leachate.
	Engineered Landfill Cap (Impermeable Cover System)	This Process Option involves grading in place of existing soils/sediments and placement of a multi-layered cap (e.g., clean soil, sand, gravel, cobbles, geotextile), including an impermeable layer (e.g., geomembrane, compacted clay) over and around affected sediment and/or soil to isolate constituents and mitigate erosion.	Soils, sediments, and groundwater	Implementable.
	Hazardous Waste Landfill Containment System	This Process Option involves removing all targeted soils/sediments, temporarily stockpiling all materials, constructing and lining a hazardous waste landfill containment cell, re-emplacing all materials within the lined cell, and constructing an impermeable cover system over the cell to isolate constituents and mitigate erosion.	Soils, sediments, and groundwater	Implementable.
2. Erosion Control	Riprap, Sheet pile	This Process Option prevents erosion (and subsequent transport) of materials by velocity control measures, barrier mechanisms, or re-impoundment of materials.	Soils and sediments	Implementable; sheet pile is already in place in some areas.
3. Hydraulic Containment	Groundwater Extraction	This Process Option includes installation of extraction wells/trenches, slurry cut-off walls, sumps, French drains for the collection of groundwater in an alignment designed to capture/ contain affected water.	Groundwater	Implementable.
	Funnel and Gate	This Process Option involves the use of an impermeable flow barrier to divert groundwater flow, may be combined with targeted groundwater removal or reactive gate.	Groundwater	Implementable; though an effective reactive gate for groundwater may not be implementable.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
F. Removal				
1. Source Excavation	Excavation/Dredging	This Process Option involves the physical removal of solid media containing constituents of concern. Potential excavation methods would include mechanical removal under "dry" or dewatered conditions and dredging of submerged materials.	Soils, sediments, (and associated groundwater or porewater)	Implementable.
2. Groundwater Removal	Extraction Wells, Drains and Trenches	This Process Option includes installation of recovery wells/trenches or drains, and the collection of groundwater for further treatment, if necessary.	Groundwater	Implementable.
G. In Situ Treatment				
Biodegradation	Natural, Enhanced	This Process Option involves degradation using microorganisms.	Soils and sediments	This process has not been successfully demonstrated to achieve target concentrations for PCBs for projects at this scale.
Immobilization	Solidification/Stabilization	This Process Option involves injecting and mixing an immobilization agent into the soil/residuals to bind constituents of concern within a solid mass (monolith).	Soils and sediments	Feasible. The anticipated large volume of material requiring treatment, increased volume from solidification media, and potential for materials within the landfill that would prevent mixing are all considerations for implementation.
	Vitrification	This Process Option involves removing water and melting soil to bind constituents of concern within a solid mass (monolith).	Soils	Not feasible for large volumes of soils/sediments. Not feasible for aquatic sediments.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
Chemical	Chemical Extraction, Chemical Destruction	In chemical treatment, chemical surfactants/solvents or oxidants are injected into the treatment area to remove or destroy constituents of concern.	Soils and sediments	Not feasible for large volumes of soils/sediments. Not feasible for aquatic sediments.
Thermal	Thermal Extraction, Thermal Destruction	In thermal treatment, soils and sediments are heated to remove or destroy constituents of concern.	Soils and sediments	This process has not been successfully demonstrated full-scale for PCBs in soils, not feasible for aquatic sediments.
H. Ex Situ Treatment				
1. Bioremediation	Enhanced	Removed soils, sediments, and/or waste are landfarmed or amended to enhance the biodegradation of constituents of concern using microorganisms and nutrients in an aerobic or anaerobic environment.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
2. Chemical	Basic Extractive Sludge Treatment (BEST)	Using the BEST approach, solvent (having inverse miscibility [i.e., resistant to dissolving] in water) is used to remove PCBs from solids.	Soils and sediments	Implementable.
	Low Energy Extraction Process (LEEP)	The LEEP option calls for the use of acetone and kerosene as solvents to extract PCB from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	Propane Extraction Process	In this extraction treatment, propane is used to extract oily organics from a water slurry of solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
	Accurex Solvent Wash	In this Process Option, a proprietary Fluorocarbon-113 and methanol solvent is used to extract PCB from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	Furfural	In this Process Option, furfural (an aromatic aldehyde) is used to extract PCBs from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	Methanol Extraction	In this Process Option, methanol is used as a solvent to extract PCBs from solids.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	Soil Washing	When implementing soil washing, solids are separated into fractions based on particle size and density. Water with surfactants can then be used to "wash" PCBs from solid fraction(s).	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	UV/Ozone/Ultrasonics	In this treatment approach, ultrasonics are used to extract PCBs from solids. PCBs destroyed by subsequent UV/ozone treatment.	Soils and sediments	Implementable; however, still an emerging technology for PCBs.
	UV/Hydrogen/Ultrasonics	In this treatment approach, ultrasonics are used to extract PCBs from solids. PCBs destroyed by subsequent UV/hydrogen treatment.	Soils and sediments	Implementable; however, still an emerging technology for PCBs.
	ELI Ecologic International, Inc. Process	This Process Option involves the gas-phase chemical reduction of organic compounds by hydrogen at temperatures of 850 °C or greater.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
	Dechlorination (Sodium based reactions [NaPEG])	This Process Option uses sodium hydroxide/polyethylene glycol to produce rapid dehalogenation of halo-organic compounds in open air systems.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	Dechlorination (Potassium polyethylene glycoate based reactions [KPEG])	This Process Option uses potassium hydroxide/polyethylene glycol to produce rapid dehalogenation of halo-organic compounds in open air systems.	Soils and sediments	Implementable; however, still an emerging technology for PCBs.
	Dechlorination (APEG-PLUS)	This Process Option uses potassium hydroxide/polyethylene glycol and dimethylsulfoxide to produce rapid dehalogenation of halo-organic compounds in open air systems.	Soils and sediments	Implementable; however, still an emerging technology for PCBs.
3. Thermal	Taciuk Process	This Process Option uses thermal extraction of PCBs from solids.	Soils and sediments	Implementable; however, still an emerging technology for PCBs.
	Low Temperature Thermal Desorption	This Process Option uses thermal separation of PCBs from solids at temperatures that volatilize PCBs. PCBs are then condensed and treated/disposed separately. Process requires TSCA permitting.	Soils and sediments	Implementable.
	Onsite incineration	Solids are thermally treated in a fluidized bed, rotary kiln, or infrared incinerator transported to the site, which would require TSCA permitting.	Soils and sediments	Implementable.
	Offsite incineration	Solids are thermally treated in a fluidized bed, rotary kiln, or infrared incinerator located offsite, which would require TSCA permitting.	Soils and sediments	Implementable.
	Pyrolysis	This Process Option uses high temperatures to decompose PCB.	Soils and sediments	Implementable.
	Radiant Energy (Photolysis)	This Process Option uses UV light energy, combined with a reducing agent, to dechlorinate PCBs.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
	Plasma Arc	In the plasma arc approach, PCBs are thermally destroyed at very high temperatures.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
	Wet Air Oxidation	This proprietary process uses special catalysts and relatively low temperature and high pressure to decompose organic compounds.	Soils and sediments	Technology has not been proven to be effective to reliably reduce PCBs to target levels for projects of this scale.
4. Immobilization	Solidification/ Stabilization	Removed soils, sediments, and/or waste materials are mixed with an immobilization agent to bind material within a solid mass (monolith).	Soils and sediments	Implementable.
	Vitrification	This Process Option is an ex-situ treatment in which solids are melted inside a chamber via electrical current, pyrolyzing PCB and incorporating remaining PCB and other constituents into glass-like monolith.	Soils and sediments	Implementable.
5. Water Treatment and Discharge	Water Treatment and Discharge	This Process Option includes treatment of groundwater through, filtration, flocculation, gravity settling, oil & grease separation, and/or activated carbon prior to discharging directly to surface water, discharging to a municipal sewer system, or reinjecting into the saturated unit.	Groundwater	Implementable.

TABLE 3-1

Initial Screening of Technologies

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Expected Process Option	Description	Potentially Applicable Media	Preliminary Assessment
I. Transportation and Disposal				
1. Offsite Disposal via Truck or Rail	TSCA-Regulated Landfill	This Process Option involves movement of soils and sediments by truck or rail for disposal in an existing TSCA permitted landfill.	Soils and sediments	Implementable.
	Solid Waste Landfill	This Process Option involves movement of soils and sediments by truck or rail for disposal in an existing permitted solid waste landfill.	Soils and sediments	Implementable.
2. Onsite Consolidation/ Disposal	Onsite Containment Cell	This Process Option involves construction of onsite containment cell and movement of soils and sediments by truck to cell.	Soils and sediments	Implementable.

Notes:

Shaded process options are screened out at this step and not retained for further evaluation.

Bolded process options are the representative process options that have been carried through for the screening evaluation of process options.

*For the purposes of this screening table, “soils” are considered to also include residuals.

BEST = Basic Extractive Sludge Treatment

IC = institutional controls

LEEP = Low Energy Extraction Process

PCBs = polychlorinated biphenyls

TSCA = Toxic Substances Control Act

TABLE 3-2
Screening of Process Options
OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Representative Process Option	Effectiveness—Ability to Meet RAOs	Reliability	Implementability	Relative Cost
A. No Further Action					
	No Further Action; reliance on IRMs implemented to date	Low for RAOs 1, 2, and 3—current exposure and potential risks outside portions of OU1 where IRMs have not been implemented would remain; benefits of IRMs with respect to satisfying RAOs in those areas would persist.	IRMs implemented to date have substantially satisfied RAOs in those areas.	N/A	N/A
B. Institutional Controls					
	Deed Restrictions	For RAO 1—Moderately effective in reducing direct human exposure to PCB containing media at the OU1 by informing future property owners of potential risks associated with the property and limiting property uses. Low effectiveness in reducing ecological exposure. Ability to meet this RAO could be further enhanced in combination with other technologies (for example, capping). None for RAOs 2 and 3—current potential for PCB migration persists; however, could be combined with other technologies to more effectively meet these RAOs (for example, capping, erosion controls).	Reliable with appropriate enforcement in place.	High—some deed restrictions are already in place. Further restrictions readily implementable on MHLLC properties. Negotiations with potentially affected landowner(s) would be necessary.	Low
	Fish Consumption Advisories	High for mitigating human exposure, and low for mitigating ecological exposure under RAO 1. Mitigates the potential for human exposure by reducing potential for consumption of fish in Portage Creek containing PCBs. Ability to meet this RAO for humans could be further enhanced in combination with other technologies. None for RAOs 2 and 3—current potential for future PCB migration persists; however, could be combined with other technologies to more effectively meet the RAOs.	Reliability is dependent on effective communication of advisories.	High—advisories currently in place can be maintained and updated until appropriate to remove.	Low
C. Monitoring					
	Periodic Visual Observations and/or Field Sampling to Monitor Site Conditions	None for RAOs 1, 2, and 3—current potential for human exposure and future PCB migration persists; however, could be combined with other technologies to confirm stability of site exposure controls, source controls, and/or containment to more effectively meet the RAOs.	Monitoring techniques well established. Reliability subject to adequacy of supporting monitoring plans.	High—readily implementable. Experienced field personnel, sampling equipment, and supplies are readily available.	Moderately Low (depending on time period and intensity of monitoring activities)
D. Containment					
1.	Access Restrictions (for example, security fencing, warning signs)	For RAO 1—Moderately effective in reducing direct human exposure to PCB containing media at the OU1 by physically restricting access and informing potential trespassers of potential risks associated with the property. Low effectiveness in reducing ecological exposure. Ability to meet this RAO could be further enhanced in combination with other technologies (for example, capping). Not effective for ecological receptors. Low for RAOs 2 and 3—current potential for future PCB migration persists; however, could be combined with other technologies to more effectively meet the RAOs (for example, capping, erosion controls).	Reliable with appropriate inspections and maintenance.	High—fencing and signage currently in place. Further restrictions readily implementable on MHLLC properties. Restrictions for other properties require landowner agreement.	Low
2. Engineered Barrier	Engineered Landfill Cap – Impermeable Cover System	High for RAOs 1 and 2—eliminates potential for human and ecological exposure to PCB via direct contact and reduces the potential for PCB migration via erosion or surface water runoff. Moderate for RAO 3—reduces surface water infiltration via the landfill cap; however, subsurface groundwater migration potential persists. Ability to meet the RAO could be further enhanced in combination with other technologies.	High—landfill capping technologies are well established, widely applied, and are proven to be reliable over long time scales at sites of similar size and characteristics.	High—experienced contractors and suitable capping materials are readily available. Landfill cover system designed equivalent to Part 115. Appropriate engineering controls are readily available to mitigate short-term risks.	Moderate to High

TABLE 3-2
Screening of Process Options
OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Representative Process Option	Effectiveness—Ability to Meet RAOs	Reliability	Implementability	Relative Cost
	Hazardous Waste Landfill Containment System	High for RAOs 1 and 2—hazardous waste landfill containment system eliminates potential for human and ecological exposure to PCB via direct contact and reduces the potential for PCB migration via erosion or surface water runoff. High for RAO 3—reduces surface water infiltration via the landfill cap; the bottom liner of the hazardous waste landfill containment cell would also reduce the potential for PCBs to migrate to the groundwater.	High—this is a proven and reliable technology.	Moderate—space limitations for stockpiling removed materials, limited capacity for final placement of all PCB containing materials, and stormwater management restrictions present significant obstacles to implementation of the hazardous waste landfill containment system process option. In addition, if required to comply with landfill design-related ARARs, the bottom of the containment cell would need to be located several feet above the water table—this would require fairly deep excavations extending below the water table, so the walls of the excavations would have to be supported, and either the excavation areas would have to be dewatered to remove in the dry, or removed materials would have to be dried/stabilized before re-emplacement of materials within the lined hazardous waste landfill containment cell.	High
2. Erosion Control	Rip Rap	In combination with capping, further enhances ability to meet RAOs 1 and 2 by reducing erosion potential of Portage Creek bank soils and thereby further maintaining stability of capping and backfill materials necessary to achieve exposure reductions and source controls. Low for RAO 3, as the remedial action does not influence groundwater conditions.	Moderate—proven and reliable long-term with proper inspection and maintenance.	High—experienced contractors and materials are readily available. Michigan Best Management Practices are available for reference.	Moderate
	Sheetpile	In combination with capping, further enhances ability to meet RAOs 1 and 2 by reducing erosion potential of Portage Creek bank soils and thereby further maintaining stability of capping and backfill materials necessary to achieve exposure reductions and source controls. Low for RAO 3, ineffective barrier for groundwater flow.	Moderate—proven and reliable long-term with proper inspection and maintenance.	High—experienced contractors and materials are readily available.	Moderate to High
3. Hydraulic Containment	Groundwater Extraction (for example, horizontal or vertical extraction wells, French drains, slurry cut-off walls, trenches, sumps to remove groundwater from locations upgradient, downgradient, or side-gradient to contaminated groundwater zone.)	Low for RAOs 1 and 2—does little to reduce potential for human and ecological exposure to PCB or PCB migration via erosion or surface water runoff. High for RAO 3—technology is geared towards mitigating potential for PCBs in groundwater to migrate offsite.	High—groundwater containment and extraction is a commonly implemented remedial technology.	High—experienced contractors and materials are readily available.	Moderate to High depending on treatment requirements, volume and duration.

TABLE 3-2
Screening of Process Options
OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Representative Process Option	Effectiveness—Ability to Meet RAOs	Reliability	Implementability	Relative Cost
E. Removal					
1. Source Excavation	Excavation	High for RAOs 1, 2, and 3 – In combination with offsite transportation and disposal, removal of PCB-containing materials would effectively reduce potential for human exposure and PCB migration in the long-term.	High—excavation is a commonly implemented remedial technology.	Moderate—experienced contractors and materials are readily available. Handling, transportation, and disposal of larger volumes of material are a significant implementation challenge.	Low for Excavation High to Very High for Transportation and Disposal (see H below)
2. Groundwater Removal	Extraction Wells and Trenches	Low for RAOs 1 and 2—does little to reduce potential for human and ecological exposure to PCB via direct contact or PCB migration via erosion or surface water runoff. High for RAO 3—technology is geared towards mitigating potential for PCBs in groundwater to migrate offsite.	High—groundwater extraction is commonly implemented remedial technology.	High—experienced contractors and materials are readily available.	Moderate to High Depending on treatment requirements, volume and duration.
F. In Situ Treatment					
1. Immobilization	Solidification	Low for RAOs 1 and 2—does little to reduce potential for human and ecological exposure to PCB via direct contact or PCB migration via erosion or surface water runoff. Increased volume of waste to 15% or more can be expected. Low for RAO 3—PCBs already have an affinity for waste material. Residual material, hydraulic conductivity 1×10^{-7} cm/sec or lower limiting the flow of groundwater through the residuals and contact with PCBs. In-situ mixing may increase hydraulic conductivity to 1×1^{-6} cm/sec or greater.	Moderate—monitoring required to determine if mixing complete throughout area treated. Would require treatability studies to determine whether site specific factors make it feasible.	Low—limited number of experienced contractors available little experience available for sites of this size. Debris from demo of structures and foundations would prevent mixing.	High—not retained based on mobilization costs, special equipment requirements, chemicals required including cost for delivery and handling, need for restoration, and implementability issues.
G. Ex Situ Treatment					
1. Chemical	Basic Extractive Sludge Treatment	Would be used in conjunction with removal actions and/or onsite consolidation to satisfy RAOs 1, 2, and 3.	Moderate—shown to be effective at destroying PCBs in soils and sediments. Would require treatability study to determine whether site-specific factors make it feasible. Has not been proven effective at treating PCBs in paper-making residuals.	Low—scale of the OU and quantity of PCB-containing materials subject to treatment presents a significant limitation to application of treatment technologies. Issues associated with offsite transportation component are present as with removal response action.	High to Very High— Not retained based on un proven applicability, and implementability. Costs for transportation, treatment and ultimate disposal of residual waste.
2. Thermal	Offsite incineration[1]	Would be used in conjunction with removal actions and/or onsite consolidation to satisfy RAOs 1, 2, and 3.	Process proven to be effective at destroying PCBs in soils and sediments. Can result in creation of dioxins.	Low—scale of the OU and quantity of PCB-containing materials subject to treatment presents a significant limitation to application of treatment technologies. Issues associated with offsite transportation component are present as with removal response action.	High to Very High— Retained for a portion of the excavated soils with the highest PCB concentrations. Requires transportation over 1,200 miles to nearest facility.

TABLE 3-2
Screening of Process Options
OU1 Feasibility Study Report—Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Response Action/Remedial Technology	Representative Process Option	Effectiveness—Ability to Meet RAOs	Reliability	Implementability	Relative Cost
3. Immobilization	Solidification/ Stabilization	Would be used in conjunction with removal actions and/or onsite consolidation to satisfy RAOs 1, 2, and 3.	Has been used ex situ full-scale at other Superfund sites. Utilized to reduce free moisture and stabilize materials for disposal purposes.	Moderate—technologies, equipment and materials are available; however, scale of the OU and quantity of PCB-containing materials subject to treatment presents a significant limitation to application of treatment technologies.	Moderate
4. Water Treatment and Discharge	Various treatment options (filtration, activated carbon) and potential discharge locations (adjacent surface waters, POTW)	Low for RAOs 1 and 2 – does little to reduce potential for human and ecological exposure to PCB via direct contact or PCB migration via erosion or surface water runoff. High for RAO 3—in combination with groundwater removal, technology addresses mitigating potential for PCBs in groundwater to migrate to Portage Creek or offsite.	High—water treatment is a proven remedial technology.	High—experienced contractors and materials are readily available.	Moderate to High
H. Transportation and Disposal					
1. Offsite Disposal	Overland transport to TSCA-Regulated and/or Solid Waste Landfill	High for RAOs 1, 2, and 3—in combination with removal, offsite transportation and disposal of PCB-containing materials would effectively reduce potential for human exposure and PCB migration in the long-term.	High—offsite transportation and disposal is commonly implemented practice.	Moderately High—experienced contractors and materials are readily available. Timing of implementation is dependent upon proper project planning and availability of offsite disposal locations. External factors (for example, community concerns, traffic routes, trucking resources, offsite landfill capacity) may limit rate of disposal and increase overall duration of remedy implementation.	High to Very High— Depending on TSCA material volumes relative to total volume.
2. Onsite Consolidation/ Disposal	Construct onsite containment cell and emplace excavated materials	In association with excavation, relocation to disposal cell would contribute to attainment of RAOs 1, 2, and 3.	Once cell completed, dependent on design and construction of cell components and cap.	Low—limited implementability subject to space limitations for onsite relocation, temporary storage, cell construction and filling operations. There may be disposal capacity constraints, depending on the volume of material to be relocated.	High to Very High

Notes:
Shading denotes process options not retained for further consideration.
IRMs = interim remedial measures
MHLLC = Millennium Holdings, LLC
N/A = not applicable
OU = operable unit
PCBs = polychlorinated biphenyls
PPE = personal protective equipment
POTW = publicly owned treatment works
RAOs = remedial action objectives
TSCA = Toxic Substances Control Act

TABLE 3-3

Retained Response Actions by Subarea

OU1 Feasibility Study Report —Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

	Soil and Sediment Response Actions								Optional Groundwater Remedy[d]
				Containment	Removal		Transportation and Disposal		Removal
Subarea	**No Further Action**	**Institutional Controls**	**Monitoring**	**Impermeable Cover System**	**Source Excavation**	**Ex Situ Treatment**	**Offsite Disposal**	**Onsite Consolidation**	**Groundwater Removal**
Former Operational Areas									
Monarch HRDL	X	X	X	X	X	X	X	X	X
Former Monarch Raceway	X	X			X	X	X	X	
Former Type III Landfill	X	X	X	X	X	X	X	X	X
Western Disposal Area	X	X	X	X	X	X	X	X	X
Portion on Panelyte Property[a]	X	X	X	X	X	X	X	X	X
Panelyte Marsh[b]	X	X	X		X	X	X	X	X
Conrail Property[c]	X	X	X	X	X	X	X	X	X
Bryant HRDL/FRDLs	X	X	X	X	X	X	X	X	X
Residential and Commercial Properties									
Residential Properties	X				X	X	X	X	
Former MHLLC-owned property (adjacent to residential properties)	X	X			X	X	X	X	
Commercial Properties (Goodwill, Consumers Power, former MHLLC's Alcott Street Parking Lot)	X	X	X	X	X	X	X	X	X

[a] Sloped area on Panelyte Property immediately north of Western Disposal Area, adjacent to Panelyte Marsh.

[b] Fringe of Panelyte Marsh at bottom of sloped area adjacent to Western Disposal Area.

[c] Portion of Conrail property immediately adjacent to Western Disposal Area.

[d] Included optional remedy—options are inclusive of various response actions to be evaluated, if appropriate based upon monitoring and performance of other remedy components.

SECTION 4

Potential Remedial Alternatives

Based on the results of the screening steps described in Section 3, the specific technologies and process options retained were assembled into a series of potential remedial alternatives that could be implemented to achieve the RAOs established for OU1. The remedial alternatives, with the exception of Alternative 1 (No Further Action), are developed to prevent erosion, direct contact, and groundwater impacts. The range of alternatives presented were developed consistent with USEPA guidance (1988), which states that alternatives with the "most favorable composite evaluation of all factors [that is, effectiveness, implementability, and cost] should be retained for further consideration during the detailed analysis." The USEPA guidance also states that the alternatives developed should "provide decision makers with an appropriate range of options" and "form alternatives for the Site as a whole." To the extent possible, the alternatives should represent "distinct viable options."

Section 4 details the potential remedial alternatives for OU1—ranging from no further action to consolidation of containments onsite to the complete removal and offsite disposal of all COC-containing materials.

4.1 Common Elements of Alternatives

For all alternatives except Alternative 1 (No Further Action), predesign investigations are required to further delineate the nature and extent of concentrations of PCBs exceeding the relevant PRGs in certain subareas of the site. As discussed in the following list, each alternative includes excavation of soil and sediment above respective PRGs in Outlying Areas and in certain subareas of the Operational Area. Based on the RI, it is assumed that by addressing PCBs, other COCs will be addressed. Confirmation sampling for PCBs and other COCs will be performed during the implementation of the remedial action to verify the assumption.

- **Operational Areas—**The Operational Areas, consisting of Bryant HRDLs and FRDLs, Monarch HRDL, Former Type III Landfill and the Western Disposal Area, are the focus of the FS and are common to each of the alternatives. During the predesign investigation, these areas will be sampled for PCBs to determine the lateral extents of PCBs exceeding the PRG of 10 mg/kg for PCBs. The management of the materials exceeding PRGs will be evaluated in the Remedial Alternatives. Portions of the following subareas are contiguous and evaluated with the Operational Areas due to encroachment of waste material. However, the following subareas are discussed separately due to the PRGs and proposed approach:
  - **Former Raceway Channel—** During the predesign investigation, sediments in this area will be sampled for PCBs. Sediment exceeding the PRG of 0.33 mg/kg will be excavated. After confirmation samples indicate the extents of excavation are less than the PRGs of 0.33 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be the wetland will be restored and an environmental covenant will be implemented to maintain the wetlands.
  - **Panelyte Property—**Waste materials are believed to have encroached onto the southern portion of the Panelyte Property from the Western Disposal Area as shown in Figures 4-2A, 4-2B, 4-3, and 4-4. During the predesign investigation, the area will be sampled for PCBs. Soils exceeding the PRG of 10 mg/kg PCBs will be excavated. After confirmation samples indicate the extents of excavation are less than 10 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be backfilled with clean material.
  - **Panelyte Marsh—**During the predesign investigation, sediments in this area will be sampled for PCBs. Sediment exceeding the PRG of 0.33 mg/kg will be excavated. After confirmation samples indicate the extents of excavation are less than the PRGs of 0.33 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the wetland will be restored and an environmental covenant will be implemented to maintain the wetlands.

- **Conrail Property—**Waste materials are believed to have encroached onto the eastern portion of the Conrail Property from the Western Disposal Area as shown in Figures 4-2A, 4-2B, 4-3, and 4-4. During the predesign investigation, the area will be sampled for PCBs. Soils exceeding the PRG of 10 mg/kg for PCBs will be excavated. After confirmation samples indicate the extents of excavation are less than 10 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be backfilled with clean material.

- **State of Michigan Cork Street Property—**Waste materials are believed to have encroached onto the Cork Street Property from the Monarch HRDL as shown in Figures 4-2A, 4-2B, 4-3, and 4-4. During the predesign investigation, the area will be sampled for PCBs. Soils exceeding the PRG of 10 mg/kg PCBs will be excavated. After confirmation samples indicate the extents of excavation are less than 10 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be backfilled with clean material.

- **Residential Subarea (Outlying)—**During the predesign investigation, the subarea identified as "Residential Properties" in Figures 4-2A, 4-2B, 4-3 and 4-4 will be sampled for PCBs. Soils exceeding the PRG of 1 mg/kg for PCBs will be excavated. After confirmation samples indicate the extents of excavation are less than the PRGs of 1 mg/kg for PCBs or Michigan Part 201 Residential Criteria for other COCs, the excavation will be backfilled with clean material.

- **Clay Seam and East Bank Area (Outlying)—**Sampling of these areas has demonstrated that they meet a cleanup level below 1 mg/kg PCBs, and thus, no further action is anticipated in these areas.

- **Commercial Properties (Outlying)—**During the predesign investigation, the areas identified as Commercial Properties in Figures 4-2A, 4-2B, 4-3, and 4-4 will be sampled for PCBs. Soils exceeding the PRG of 10 mg/kg PCBs will be excavated. After confirmation samples indicate the extents of excavation are less than 10 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be backfilled with clean material mg/kg. Subareas achieving PRGs between 1 mg/kg and 10 mg/kg will require restrictive covenants preventing high occupancy use. Where there are buildings that serve to mitigate direct contact and hinder the ability to remove impacted materials, restrictive covenants will be employed that requiring sampling and removal when existing structures are compromised. Parking lots will be investigated and excavated to meet PRGs, as necessary.

  - **Alcott Street Parking Lot (owned by Lyondell Trust [formerly MHLLC]) south of Alcott Street (Outlying)—**This area will be sampled during the predesign investigation. Soils will be excavated to achieve a PRG of less than 10 mg/kg PCBs or Michigan Part 201 Non-Residential Criteria for other COCs. If parking lots or other paved areas are excavated, the area will be restored. A restrictive covenant will be required to prohibit high occupancy use on this area.

  - **Former Filter Plant (Outlying)—**During the predesign investigation, the former Filter Plant area, as identified in Figures 4-2A, 4-2B, 4-3 and 4-4 will be sampled for PCBs. Soils exceeding the PRG of 10 mg/kg PCBs will be excavated. After confirmation samples indicate the extents of excavation are less than 10 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be backfilled with clean material.

  - **Former Bryant Mill Pond Area (Outlying)—**During the predesign investigation, soils in the Former Bryant Mill Pond will be sampled for PCBs in the area of seeps and sediment in the associated wetland area. Soils exceeding the cleanup level of 10 mg/kg PCBs, floodplain soils exceeding the PRG of 6.5 to 8.1 mg/kg and sediment exceeding 0.33 mg/kg will be excavated. After confirmation samples indicate the extents of excavation are less than the respective PRGs for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the excavation will be backfilled with clean material. Wetlands were previously delineated in the Former Bryant Mill Pond Area and at least 1 acre of wetland will be mitigated for each acre filled. An environmental covenant will be implemented to maintain wetland areas.

- **Wetland Areas—**Known wetland areas have been discussed with the associated subareas. However, if additional wetland areas with suspected PCB impacts are identified within the Outlying or Operational Areas during the predesign investigation, the wetlands will be investigated for PCBs. Sediment exceeding the PRG of 0.33 mg/kg will be excavated. After confirmation samples indicate the extents of excavation are less than 0.33 mg/kg for PCBs or Michigan Part 201 Non-Residential Criteria for other COCs, the wetland will be restored and an environmental covenant will be implemented to maintain the wetlands.
- Known floodplain soils within the Outlying or Operational Areas have been discussed with the associated subareas. However, if additional floodplain soils with suspected PCB impacts are identified within the Outlying or Operational Areas during the predesign investigation, the area will be investigated for PCBs. Floodplain soils exceeding the PRG of 6.5 to 8.1 mg/kg for PCBs will be excavated.

The 2,600 linear feet of sealed-joint sheet pile installed in 2001 along the western bank of Portage Creek was installed to stabilize the perimeter berms of the Bryant HRDLs and FRDLs. Except for Alternative 1, partial or complete removal of the existing sheet pile wall has been evaluated as a component of the alternatives.

4.2 Alternative 1—No Further Action

The No Further Action alternative is required in the FS under the National Oil and Hazardous Substances Pollution Contingency Plan and serves as a baseline against which the other potential remedial alternatives can be compared.

No further active remediation would be performed in any portion of OU1 under this alternative. Natural attenuation processes would continue, but would not be monitored to gauge progress toward the RAOs. The potential for human and ecological receptors to be exposed to COCs would not be addressed, and there would remain a potential for COCs to erode into Portage Creek over time since there would be no maintenance of the existing fence, cap, soil cover, or the other engineered control systems. Operation of the groundwater collection/treatment system would be discontinued. Alternative 1 is depicted in Figure 4-1.

4.3 Alternative 2—Consolidation and Capping

The primary element of Alternative 2 is in-place containment with erosion control measures including consolidation of the Outlying Areas and portions of the Operational Areas into the Bryant HRDLs/FRDLs and Monarch HRDL. The Bryant HRDLs/FRDLs Area will include the adjacent Former Type III Landfill and Western Disposal Areas. Alternative 2, described in the following section, was developed to present options for addressing the Outlying Areas within OU1. Three variations of Alternative 2 were developed, Alternatives 2A, 2B, and 2C, to allow for variations in the consolidation of the excavated materials. Alternative 2 is depicted in Figures 4-2a and 4-2b.

Alternative 2 includes covering the landfills after consolidation with an engineered composite landfill cap. For the purpose of FS cost-estimating, it is assumed the cap will consists of six layers as shown in Figure 4-2c. The layers are (from bottom to top): a non-woven geotextile, a 12-inch-thick (minimum) sand gas venting layer, a 30-millimeter polyvinyl chloride FML or equivalent (permeability less than 1×10^{-10} centimeters per second), a geosynthetic drainage composite layer, a 24-inch-thick (minimum) drainage and soil protection layer, and a 6-inch-thick (minimum) vegetated, topsoil layer. The proposed cap design contains the landfill cap components required under NREPA, as amended, Part 115.

The existing sheet pile wall will be evaluated during design to determine if it can be removed completely or is required to stabilize the base of the landfill along Portage Creek. If the wall is required for stabilization, the wall will be cut off at ground surface and individual panels may be removed to allow groundwater flow to the creek, eliminating the need for the existing collection system.

Portions of the Bryant HRDLs/FRDLs, Monarch HRDL, Former Type III Landfill, and Western Disposal Area perimeter will be excavated/pulled back and consolidated within the onsite disposal areas to create a setback that will act as a protective buffer along the creek and to enhance long-term slope stability. Alternative 2 options include long-term inspections and maintenance of the existing and newly installed engineered landfill caps, and the remaining sheet pile. A long-term monitoring program will be implemented to verify the performance of the remedy, demonstrate that groundwater quality conforms to applicable criteria, and to provide for the appropriate management of landfill gas.

The clean set back between the landfill and Portage Creek will allow room for monitoring wells and an optional groundwater collection treatment system. The groundwater monitoring network consisting of existing and new monitoring wells (as needed) will be located outside areas where waste remains in place (Bryant HRDLs/FRDLs and or/Monarch HRDL Areas). The groundwater monitoring plan would also evaluate upgradient groundwater concentrations for determination of local background conditions. For the purposes of the FS, it was assumed that 24 monitoring wells would be installed for monitoring in Alternative 2A, and 20 monitoring wells will be installed as part of Alternatives 2B and 2C.

The monitoring wells will be sampled in accordance with NREPA Part 201 and (40 CFR § Section 761.75(b) (6) and according to a plan to be developed by USEPA to monitor the performance of the remedy for RAO 3. Following each sampling event, the analytical results will undergo data validation, and the validated analytical results will be compared to Michigan Act 451 Part 201 Generic Screening Criteria. Analytical results from groundwater samples collected from monitoring wells adjacent to Portage Creek will be compared to the GSI criterion to demonstrate compliance with GSI criteria at Portage Creek under MCL 324.20120e for containment alternatives. Analytical results for samples taken in non-GSI areas will be compared to other appropriate criteria (for example, groundwater protection screening criteria).

Alternative 2 options include subalternatives for hydraulic control of groundwater. For subalternative (i), USEPA would install a groundwater collection and treatment system. The groundwater collection and treatment system would consist of groundwater extraction wells and a series of sumps and lateral drain lines. For subalternative (ii), a grout slurry wall would be installed downgradient of the Bryant HRDLs/FRDLs and Monarch HRDL (if left in place) to contain impacted groundwater located within OU1 as subalternative (ii). The slurry wall would extend approximately 40 feet below ground surface based on current sheet pile wall design. It is assumed that the slurry wall will not necessarily key into clay or bedrock—portions of the slurry wall at this depth would still terminate in the upper sand zones. Subalternative (ii) includes the same groundwater collection and treatment system as subalternative (i).

Alternative 2 includes restrictive covenants to prevent exposure of PCBs at depth and prohibit interference with the cap, informational devices, and access restrictions consisting of perimeter fence with posted warning signs.

4.3.1 Alternative 2A—Consolidation of Outlying Areas on HRDL/FRDL and Monarch HRDLs

Under Alternative 2A, the excavated material from the Outlying Areas and certain perimeter areas of the Operational Area would be consolidated on the Bryant HRDLs/FRDLs and Monarch HRDL. The areas targeted for excavation and consolidation are shown in Figure 4-2a. After consolidation, each landfill would be covered with an engineered cap as described in Section 4.3.

4.3.2 Alternative 2B—Consolidation of Outlying Areas and the Monarch HRDL on HRDL/FRDL

Under Alternative 2B, the excavated material from the Outlying Areas and certain perimeter areas of the Operational Area would be consolidated on the Bryant HRDLs/FRDLs Landfill. The Monarch HRDL would also be excavated and consolidated on the Bryant HRDLs/FRDLs Landfill. The areas targeted for excavation and consolidation are shown in Figure 4-2b. The subsequent capping of the Bryant HRDLs/FRDLs would be conducted as described in Section 4.3.

4.3.3 Alternative 2C—Consolidation of Outlying Areas and the Monarch HRDL on HRDL/FRDL with Offsite Incineration of Excavated Materials with PCBs Greater than 500 mg/kg

The extents of excavation and the consolidation areas are the same for Alternative 2C as described under Alternative 2B and are shown in Figure 4-2b. Excavated materials with PCB concentrations above 500 mg/kg would be transported for offsite incineration. Remaining materials with PCB concentrations of 500 mg/kg or less would be consolidated on the Bryant HRDLs/FRDLs and subsequently capped.

The design investigation will be used to identify hot spots within the area to be consolidated with PCB concentrations greater than 500 mg/kg. For the purpose of the feasibility study, it is assumed that approximately 5 percent of the soils excavated from the pullback near the Western Disposal Area and Former Type III Landfill would require offsite incineration. Approximately 2 percent of soils excavated from Outlying Areas, Monarch HRDL, and the setback between Portage Creek and Bryant HRDLS/FRDLs would require offsite incineration. The assumptions are based on the cumulative distribution functions performed in a statistical evaluation by the USEPA FIeld EnvironmentaL Decision Support (FIELDS) Team using the existing data sets (Appendix E).

4.4 Alternative 3—Total Removal and Offsite Disposal

The primary element of Alternative 3 is the excavation and offsite disposal of all areas where PCBs exceed PRGs. The excavation areas are shown on Figure 4-3 and include the following:

- All Outlying Areas other than the portion of the Goodwill property that may be covered by buildings.
- Former Operational Areas—The Monarch HRDL, the Former Type III Landfill, the Western Disposal Area and the Bryant HRDLs/FRDLs and portions of contiguous properties, including where waste materials are suspected to have encroached from Western Disposal Area, including portions of Panelyte Marsh, Panelyte Property, the Conrail Railroad Property and the State of Michigan's Cork Street Property.

Materials will be excavated and transported directly to offsite commercial landfills. Materials with PCB concentrations of 50 mg/kg or greater would be transported to and disposed of in approved offsite landfills permitted to receive TSCA-regulated wastes. Materials with PCB concentrations less than 50 mg/kg would be transported to and disposed of at other permitted and approved landfills as appropriate. Excluded from removal are the PCB-containing materials that may be located under existing buildings on the Goodwill property.

Post-removal confirmatory sampling and analysis would be performed at the excavation areas. Once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated or otherwise restored to match the surrounding areas. The Panelyte Marsh, the Former Monarch Raceway Channel, and other wetland areas would be backfilled to existing grades and restored to promote the re-establishment of wetland vegetation. The excavated and backfilled area would extend across approximately 65 acres. Restrictive covenants to maintain wetlands areas will be required.

In addition, part of this alternative would include the removal of 2,600 linear feet of sealed-joint sheet pile along the western bank of Portage Creek to the extent feasible. The groundwater treatment system would be decommissioned and removed, and the network of groundwater extraction trenches, sumps, and wells currently in place behind the sheet pile wall would be removed and disposed.

This alternative is developed with the intent of removal of all material containing COCs above OU1 PRGs. However, if it is not feasible to remove some of the material, groundwater monitoring would be performed in areas where exceedances remain. Monitoring would be performed as described in Section 4.3. Institutional controls (for example, restrictive covenants and enforcement tools) would be implemented for the areas where COCs may be left in place.

4.5 Alternative 4—Encapsulation Containment System

The primary element of Alternative 4 is the full encapsulation of impacted materials onsite as shown in Figure 4-4, including the following:

- Excavate approximately 1,600,000 yd^3 of soil and/or sediment containing PCBs above the relevant PRGs as described for Alternative 3
- Construct a landfill bottom liner in previously excavated former landfill areas
- Place excavated materials on the newly constructed landfill liner

- Construct a landfill cap over the new landfill areas (same cap construction as Alternative 2 in Section 4.3)
- Some materials could be volumetrically displaced and would be disposed of in offsite commercial landfills

The same areas identified in Alternative 3 are targeted for excavation in Alternative 4 (Figure 4-4).

In the Outlying Areas, once cleanup goals have been achieved, the excavated areas would be backfilled with clean material, graded to mitigate ponding, and revegetated or otherwise restored to match the surrounding area. The Panelyte Marsh and Former Monarch Raceway Channel would be backfilled to existing grades and restored to promote the re-establishment of wetland vegetation. All excavated materials would be sequentially stockpiled onsite during construction of a series of landfill containment cells, constructed onsite in the locations of the current Former Operational Areas.

Work in the Former Operational Areas could be carried out in the following manner:

- Excavate soils from the Monarch HRDL and temporarily stage the soils in the Western Disposal Area. Backfill the Monarch HRDL with approximately 10 feet of imported clean fill to establish the base liner 4 feet above the water table for the disposal cell. Construct the base liner, transport approximately 75 percent of the excavated Monarch HRDL soils back to the Monarch cell, place/grade/compact the soils, and construct the final cap. The remaining 25 percent of soils volumetrically displaced would be transported offsite for disposal.
- Repeat the above process for the Bryant HRDLs/FRDLs, then for the Former Type III Landfill.
- Repeat the above process for the western half of the Western Disposal Area, but do not construct the final cap.
- Complete the process for the eastern half of the Western Disposal Area, and then construct the final cap over the entire Western Disposal Area.

The containment system disposal cells would be designed and built to include a double composite base liner system constructed a minimum distance of 10 feet above the groundwater table and graded to a minimum slope of 2 percent to promote drainage. For the purposes of FS cost estimating, it is assumed the base liner system would consist of the following components from top down as shown in Figure 4-4a: a 40-mil primary FML, underlain by a geosynthetic clay liner (GCL), a leachate collection system consisting of a geosynthetic drainage composite (GDC) layer (consisting of a geonet that is heat-bonded on each side to a non-woven needle-punched geotextile) draining to a pumpable sump system, a leak detection system, a secondary 40-mil FML, and a secondary 3-foot compacted clay liner (or geosynthetic equivalent). The GCL would have a maximum hydraulic conductivity of 1×10^{-7} centimeters per second, and the GDC would have a minimum transmissivity of 3×10^{-4} square meters per second.

The removed materials would be placed within the disposal cells with a cover liner system sloped to grades of no less than 4 percent and consisting of the following components, from top down: a 6-inch vegetative soil layer, a 24-inch protective soil layer, a GDC (as described above), a 40-mil FML, a GCL, a non-woven needle-punched geotextile, a minimum 12-inch gas-venting layer with gas vents at appropriately spaced intervals, a basal non-woven needle-punched geotextile, and a soil grading layer. The cap would be constructed with appropriate erosion controls and other measures to protect against flood events and other natural or human-induced incidents that might otherwise threaten the integrity of the disposal areas. The final cap would cover approximately 50 acres.

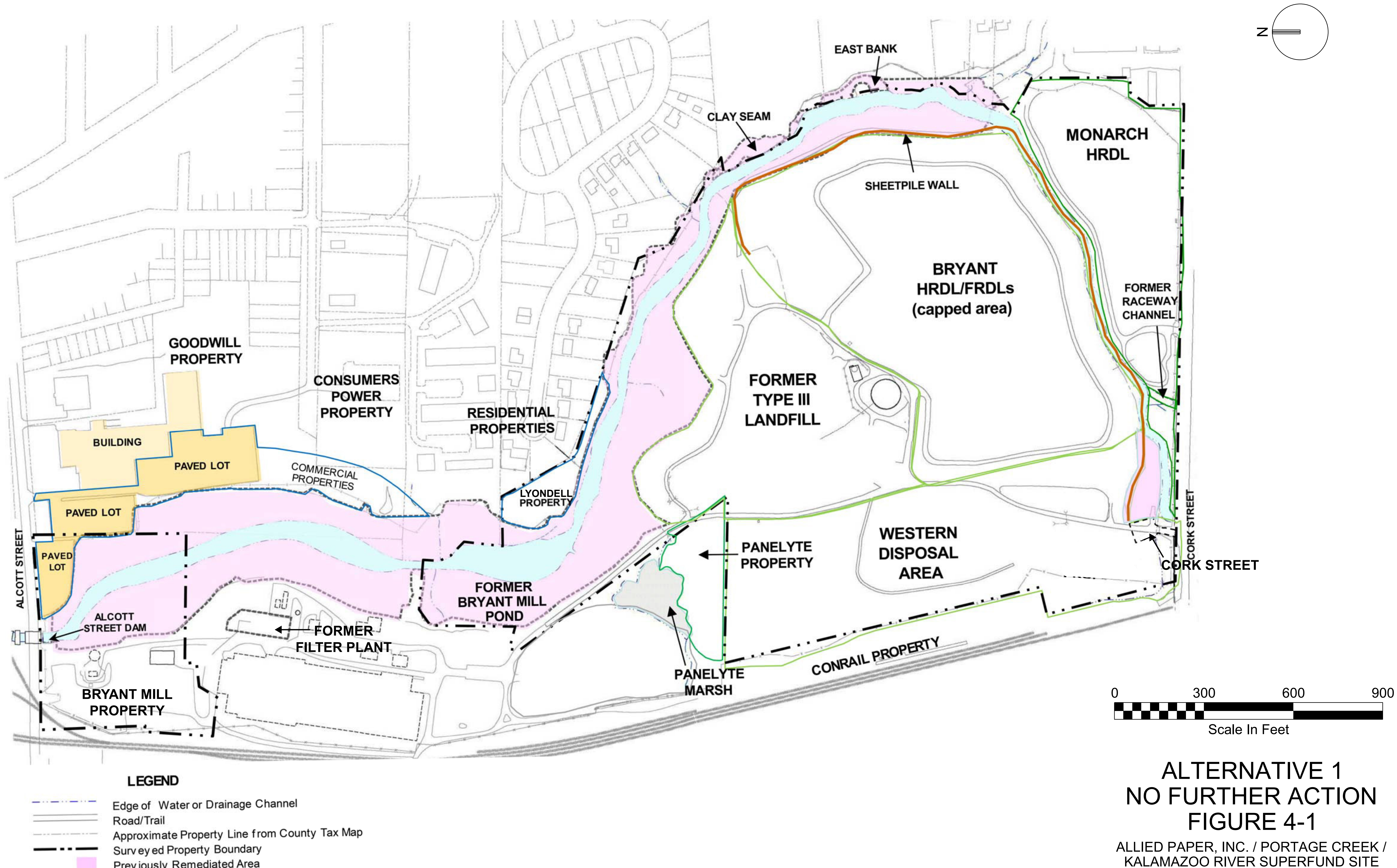
Excess excavated materials that do not fit in the landfill containment cells (height of the cells is limited due to the need to attain the desired side slope grade) would be transported to and disposed of in appropriately permitted offsite landfills. Approximately 25 percent of the soils targeted for excavation and re-emplacement in the Former Operational Areas and all of the soils excavated from the offsite outlying areas would be volumetrically displaced, which means that more than 500,000 yd^3 of materials would have to be transported offsite for disposal.

The materials would be transported to and disposed of in offsite landfills. Materials with PCB concentrations of 50 mg/kg or greater would be transported to and disposed of in approved offsite landfills permitted to receive

TSCA-regulated wastes. Materials with PCB concentrations less than 50 mg/kg would be transported to and disposed of at other permitted and approved landfills as appropriate. It is anticipated that TSCA-regulated wastes would be placed into the consolidation system and volumetrically displaced materials would be limited to materials with PCB concentrations less than 50 mg/kg. Excluded from removal are the PCB-containing materials that may be located under existing buildings on the Goodwill property. Excavated areas will be backfilled with clean material, graded, and revegetated or otherwise restored to match the surrounding areas. The excavated and backfilled area would extend across approximately 65 acres.

Part of this alternative would include removal of 2,600 linear feet of sealed-joint sheet pile along the western bank of Portage Creek. The need to leave portions of the sheet pile wall in place for landfill slope and bank stability will be further evaluated in the design should this alternative be selected. The potential for groundwater mounding behind the wall will be included as part of the evaluation. The groundwater treatment system would be decommissioned and removed, and the network of groundwater extraction trenches, sumps, and wells currently in place behind the sheet pile wall would be removed and disposed of.

Under Alternative 4, USEPA would establish the groundwater monitoring system as described in Section 4.3 for Alternative 2 options.

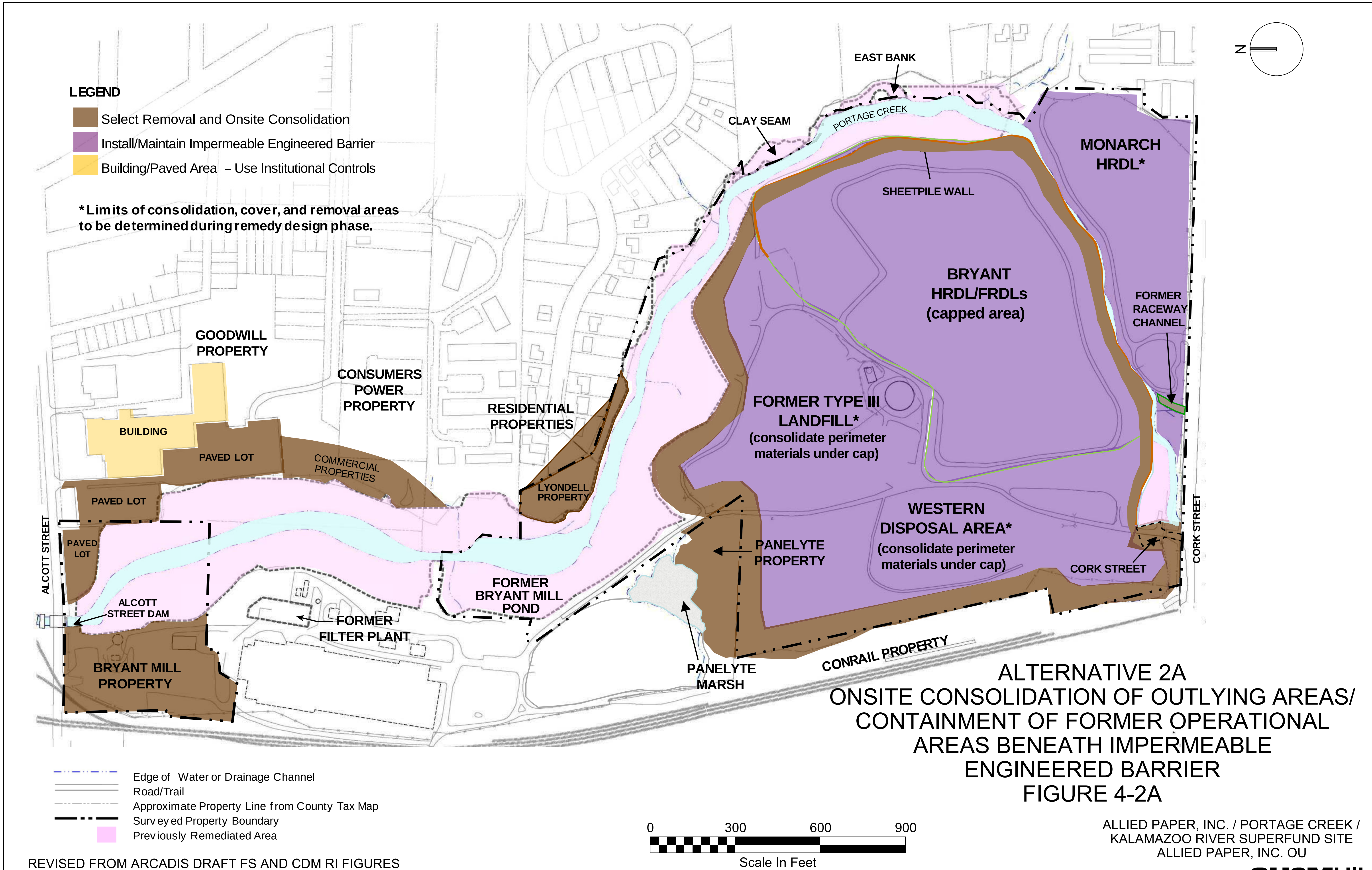


ALTERNATIVE 1
NO FURTHER ACTION
FIGURE 4-1

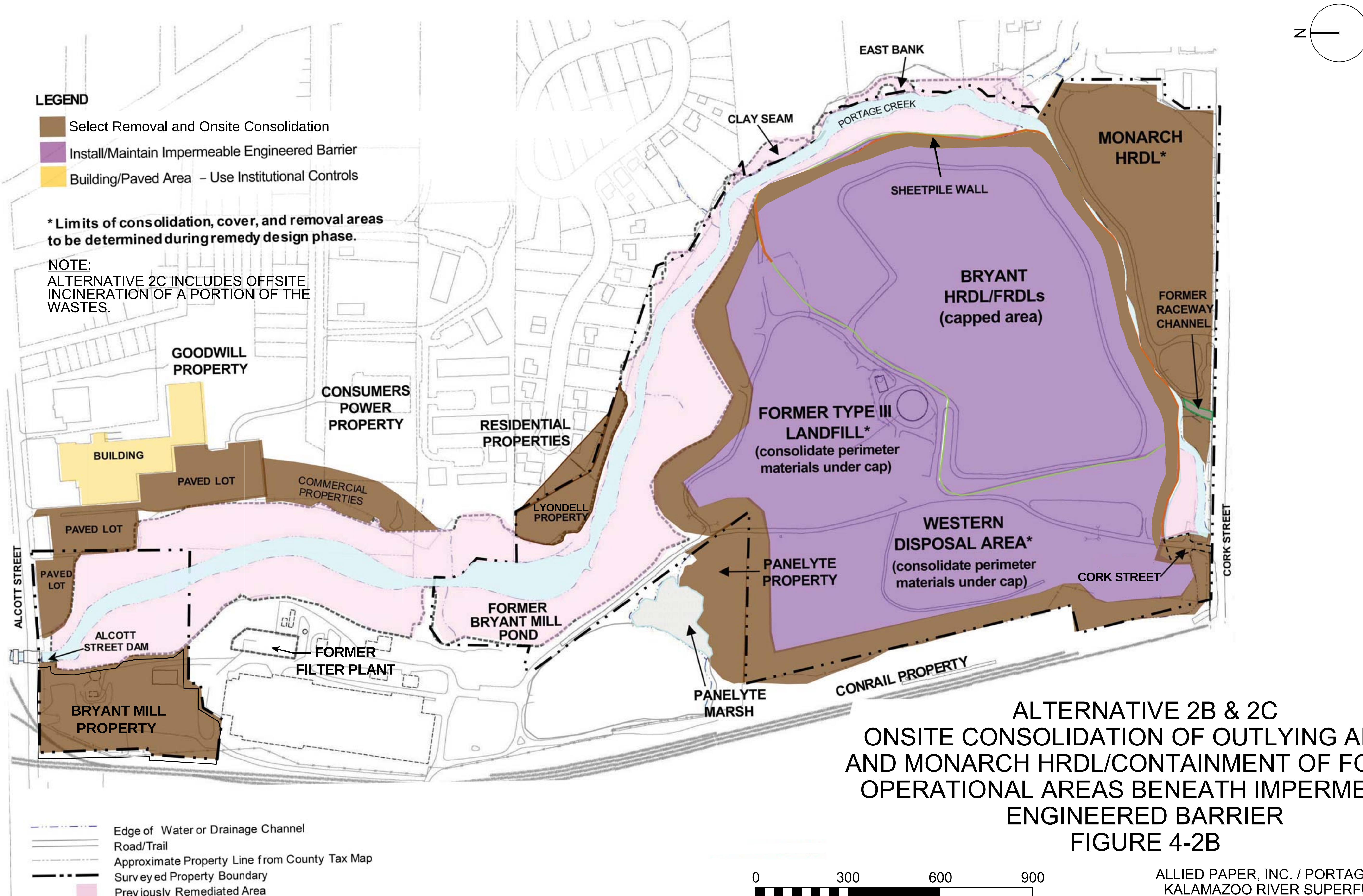
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

CH2MHILL



ALTERNATIVE 2A
ONSITE CONSOLIDATION OF OUTLYING AREAS/ CONTAINMENT OF FORMER OPERATIONAL AREAS BENEATH IMPERMEABLE ENGINEERED BARRIER
FIGURE 4-2A



ALTERNATIVE 2B & 2C
ONSITE CONSOLIDATION OF OUTLYING AREAS AND MONARCH HRDL/CONTAINMENT OF FORMER OPERATIONAL AREAS BENEATH IMPERMEABLE ENGINEERED BARRIER
FIGURE 4-2B

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

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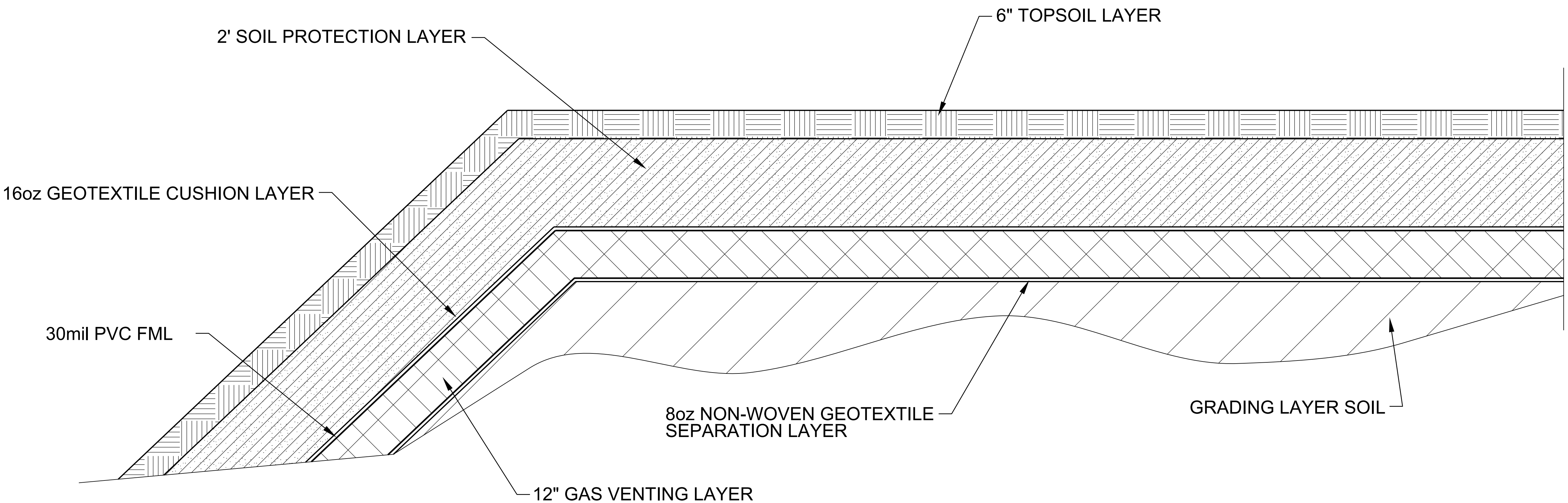
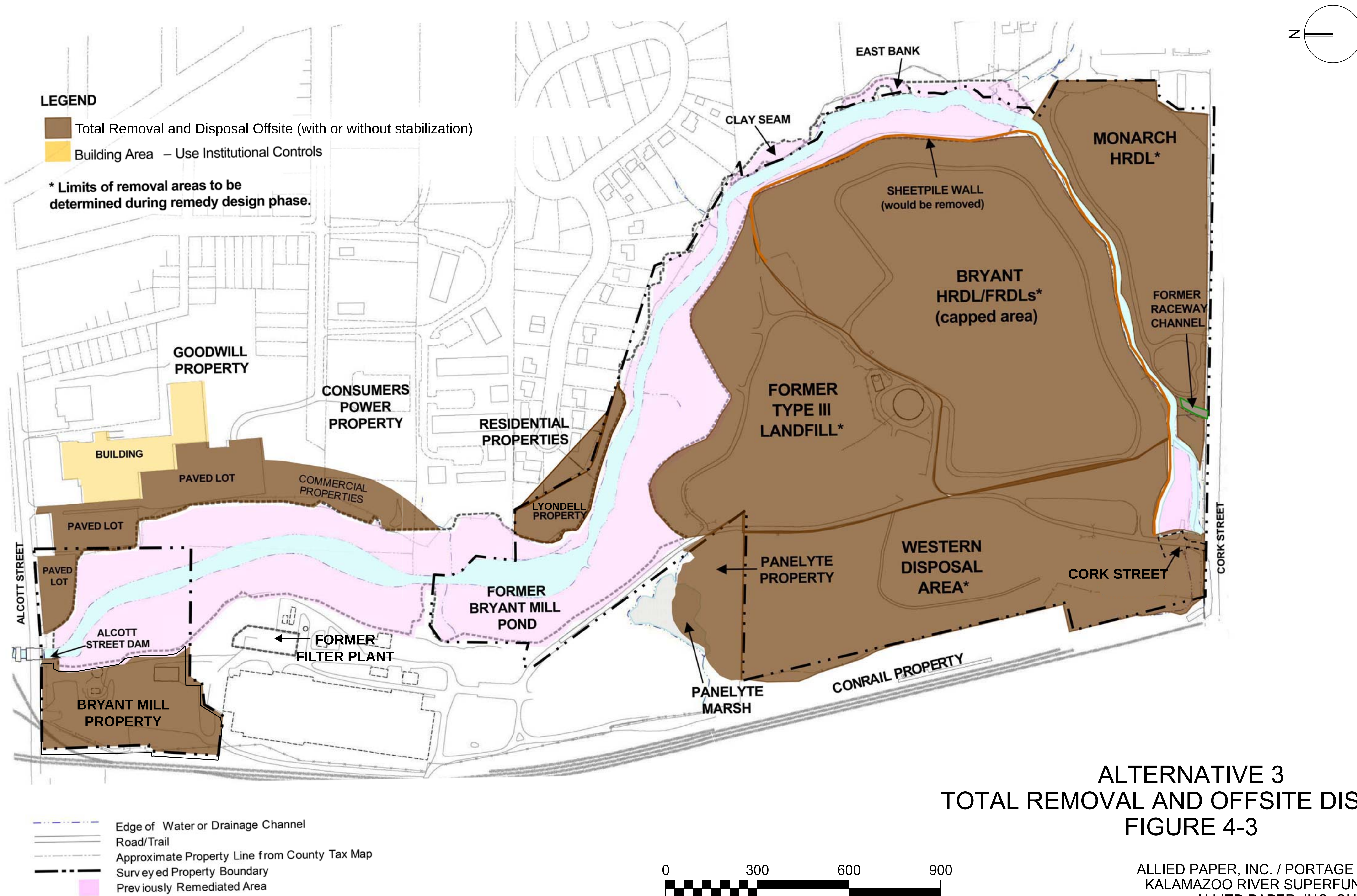


ALTERNATIVE 2A, B & C CONTAINMENT SYSTEM CAP LINER SECTION FIGURE 4-2C

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE ALLIED PAPER, INC. OU

CH2MHILL



ALTERNATIVE 3
TOTAL REMOVAL AND OFFSITE DISPOSAL
FIGURE 4-3

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

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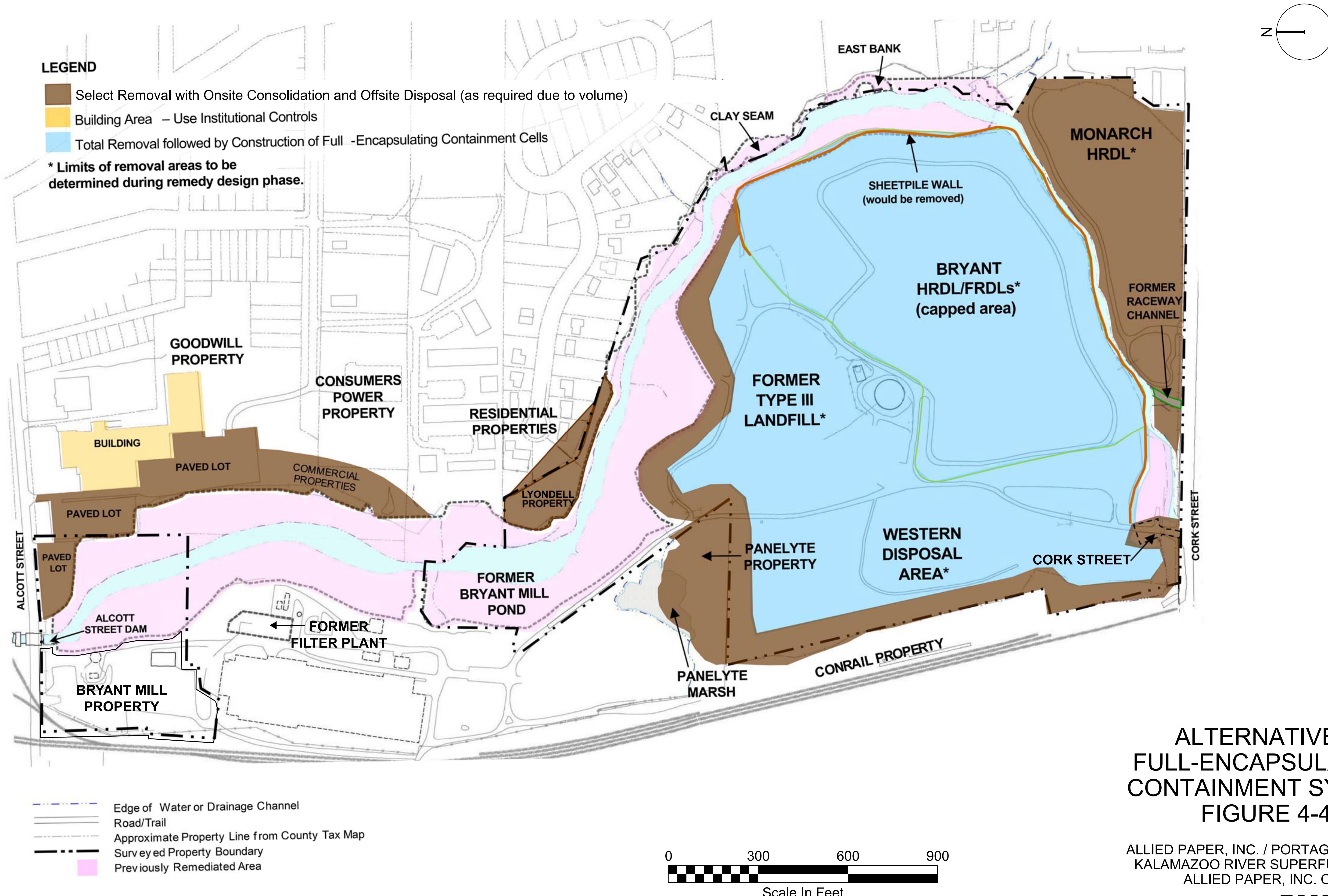

ALTERNATIVE 4
FULL-ENCAPSULATING CONTAINMENT SYSTEM
FIGURE 4-4

ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

REVISED FROM ARCADIS DRAFT FS AND CDM RI FIGURES

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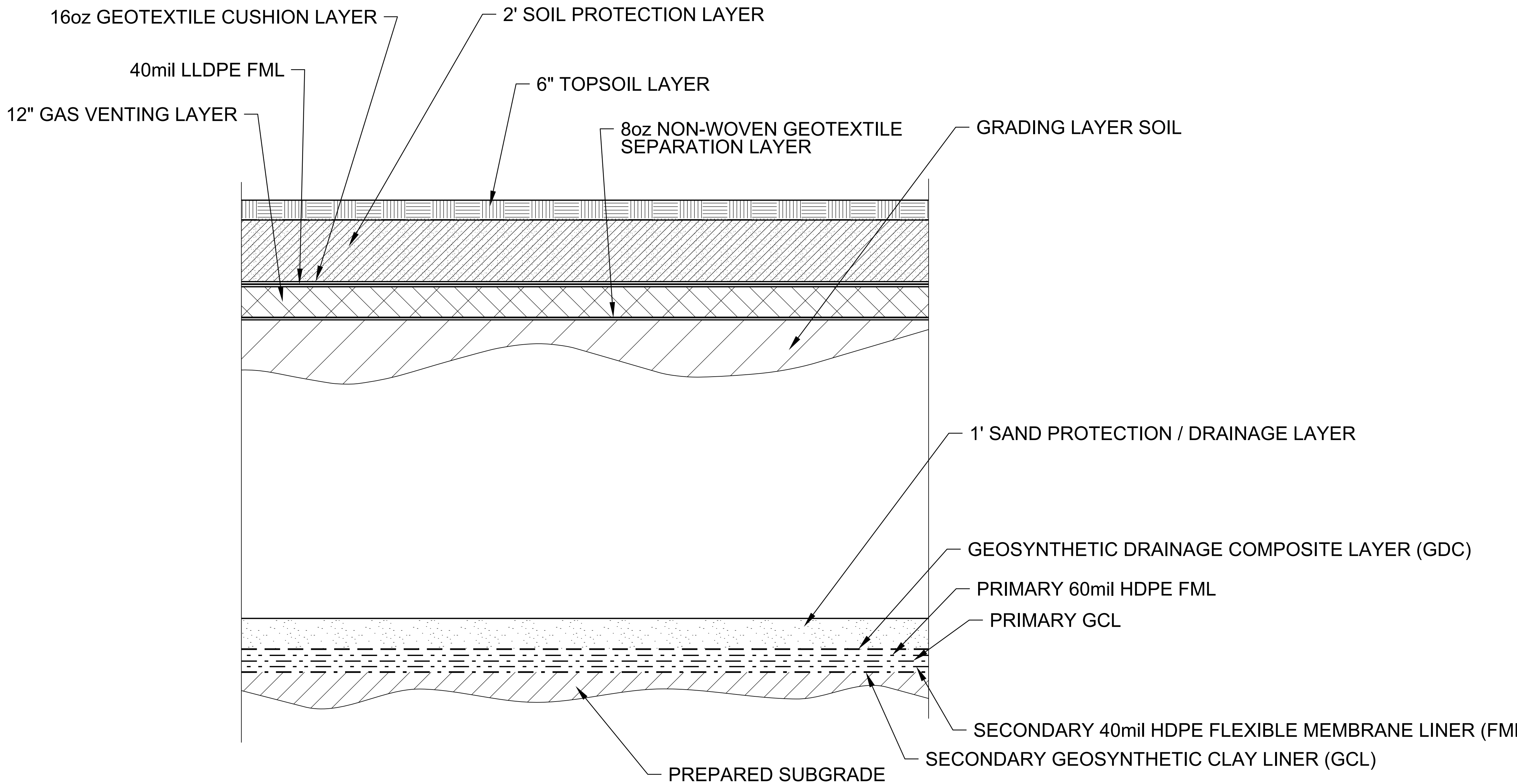

ALTERNATIVE 4
CONTAINMENT SYSTEM CAP
AND BASE LINER SECTION
FIGURE 4-4A

ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

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SECTION 5

Detailed Evaluation of Remedial Alternatives

Each potential remedial alternative identified in Section 4 was assessed in accordance with guidelines set forth in CERCLA. Key elements considered in the evaluation of each alternative included the following:

- **Overall Protection of Human Health and the Environment—**This element assesses the overall effectiveness of an alternative in protecting human health and the environment by reducing potential exposures and achieving the identified RAOs (Section 2.2). This element considers whether the alternative reduces risks and maintains protectiveness over time and whether the alternative meets RAOs.
- **Compliance with Applicable or Relevant and Appropriate Requirements—**This element assesses whether an alternative complies with identified ARARs or whether waivers are necessary.
- **Long-term Effectiveness and Permanence—**This element assesses the effectiveness of an alternative with respect to reducing exposure and potential risk and the ability to maintain protectiveness over time. This element considers whether the alternative maintains protection of human health and the environment after RAOs have been met.
- **Reduction of Toxicity, Mobility, or Volume through Treatment—**This element assesses expected reductions in toxicity, mobility, or volume of impacted media.
- **Short-term Effectiveness—**This element assesses short-term impacts to human health and the environment related to construction and implementation of an alternative. This element considers the short-term environmental impacts of construction, the protection of onsite workers and the neighboring community, and the duration until the RAOs are achieved. The durations evaluated in this FS assume production rates are determined by the technical assumptions listed and are not impacted by funding, capacity limitations or other considerations.
- **Implementability—**This element assesses the implementability of an alternative with respect to both technical and administrative feasibility, including the availability of appropriate services and materials. Technical implementability includes the ability to construct and operate the technology, the reliability of the technology, and the ability to effectively monitor the technology. Administrative feasibility includes the degree to which any coordination with other government agencies (including local governments) can be achieved. This element considers whether implementing an alternative is technically and administratively feasible, whether trained workers, equipment, and materials are readily available, and how long it will take to implement an alternative.
- **Cost—**This element assesses capital, O&M, and the present worth of implementing an alternative. Present-worth costs, where appropriate, are developed using the real discount rate of 1.1 percent from Appendix C of OMB Circular A-94 (revised January 14, 2013) for use on federally funded projects such as CERCLA based on OSWER Directive No. 9355.0-75 (USEPA 2000). In consideration of engineering and construction contingencies, the feasibility-level costs are typically estimated with an accuracy in the range of +50 percent to -30 percent. This element considers the cost to implement and maintain an alternative and monitor its effectiveness.

Each alternative is evaluated individually based on the seven elements presented above followed by a comparative assessment in Section 6. The results of the evaluations will be used by USEPA in the identification of a recommended alternative for OU1.

USEPA addresses the CERCLA criteria of State Acceptance and Community Acceptance in the development of the Record of Decision (ROD). The ROD will establish the cleanup standards for OU1. The cleanup standards may be PRGs presented in Section 2.3 or modified as deemed appropriate. PRGs are used in this section for the evaluation of the remedial alternatives prior to the establishment of the cleanup standards. The cleanup criteria will be carried forward into the RD.

5.1 Alternative 1—No Further Action

Development of a no further action alternative is required under the National Oil and Hazardous Substances Pollution Contingency Plan. The no further action alternative provides a comparative baseline against which other alternatives can be evaluated. Under Alternative 1, no further remedial action would be taken beyond the already completed TCRA in the Former Bryant Mill Pond and the IRMs (described in Section 1.3.2) implemented across OU1. The PCB-containing soils and residuals would be left in place, without the implementation of any further containment, removal, treatment, or other mitigating actions.

Natural attenuation processes would continue; however, environmental media within OU1 would not be monitored to assess progress toward achieving the RAOs. Alternative 1 does not provide for any active or passive institutional controls to reduce the potential for exposure (for example, physical barriers and restrictive covenants), nor does it address the existing potential risks to humans and ecological receptors associated with OU1.

5.1.1 Overall Protection of Human Health and the Environment

Under Alternative 1, the existing engineered cap over the Bryant HRDLs/FRDLs would not be inspected or maintained, the sheet pile along the western bank of Portage Creek would not be maintained, the groundwater collection and treatment system would not be run, and no institutional controls would be recorded to restrict access to OU1 or prevent the use of groundwater. The potential for exposure to materials with concentrations exceeding applicable PRGs would remain.

Current conditions at OU1 are generally stable relative to the ongoing potential for migration of COCs, and many source areas have been addressed; however, Alternative 1 provides no improved protection over the current conditions, provides no additional risk reduction, and is not expected to be protective of human health and the environment over the long term. The TCRA and IRMs completed to date have substantially satisfied the RAOs, but current exposure and potential risks in the Outlying Areas and portions of OU1 where IRMs have not been implemented would persist. Risks would likely increase over time if material exceeding OU1 PRGs in the uncapped disposal areas (such as, Monarch HRDL, Former Type III Landfill, and Western Disposal Area) became exposed and eroded into Portage Creek, the sheet pile wall failed, or the engineered cap was compromised and materials that are currently isolated/contained were exposed or released.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Since no active remedial efforts are proposed under Alternative 1, most of the action- and location-specific ARARs do not apply. The following specific ARARs would not be achieved if Alternative 1 were selected:

- **Part 201, Environmental Remediation, of NREPA, 1994 Public Act (PA) 451, as amended (Part 201).** This state ARAR establishes the identification, risk assessment, evaluation, and remediation of contaminated sites within the state. It establishes generic cleanup criteria and allows development of additional site-specific criteria to protect the environment, considering ecological risks (Section 20120(a)(17)).

  Alternative 1 would not reduce exposure or associated risk and would not achieve a degree of protectiveness for the property, as required in Part 201, Sections 20120a and 20120b. The potential for exposure to COC-containing residuals/soils and the potential migration of COC-contaminated material would still exist. Alternative 1 would not satisfy the requirements for long-term monitoring, achieve the requirement to restrict future land use, nor comply with Part 201 if transport of COCs to surface water occurs.

- **Part 31, Water Resources Protection, of NREPA, 1994 PA 451, as amended (Part 31).** This state ARAR establishes state criteria for rivers, creeks, and floodplain areas to protect aquatic life and human health. It also establishes water quality standards and monitoring requirements for discharge effluents, including stormwater and venting groundwater, specifying standards for several water quality parameters, including COCs. Alternative 1 would not prevent stormwater or venting groundwater discharges to Portage Creek.

- **TSCA 40 CFR § 761.61.** TSCA regulations found at 40 CFR § 761.61 provide cleanup and disposal options for PCB remediation waste. Alternative 1 would not achieve this ARAR because no action would pose an unreasonable risk of injury to health or the environment under 40 CFR § 761.61(c).

5.1.3 Long-term Effectiveness and Permanence

Implementation of Alternative 1 would not achieve RAOs 1, 2, or, 3, and would not provide or maintain protection of human health or the environment over the long term. The potential for exposure to COCs in areas where IRMs have not been implemented would remain, and the potential for the long-term effectiveness of the existing engineered cap and sheet pile to be compromised would increase over time if the current inspection and maintenance program were discontinued. As a result, the potential for unacceptable long-term risks to human health and the environment would remain.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Implementation of Alternative 1 does not include any active remedial components. Therefore, it does not address the federal statutory preference for a remedy that employs treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of COC-containing materials through treatment.

5.1.5 Short-term Effectiveness

No active remedial measures are proposed as part of Alternative 1; therefore, no potential short-term adverse impacts associated with construction or implementation of Alternative 1 exist. However, existing measures controlling access to OU1 would not be maintained, potentially increasing the risk of dermal exposure over the short term if individuals trespassed onto the property and contacted surficial materials containing COCs.

5.1.6 Implementability

Alternative 1 would be both technically and administratively implementable because no active remediation would occur. No equipment or specialized services would be required to implement the alternative, and no specific approvals would be necessary.

5.1.7 Cost

No capital or O&M costs are associated with the selection of Alternative 1. However, costs for 5-year reviews are included for a total cost of $120,000 as shown in Table 5-1.

5.2 Alternative 2—Consolidation and Capping

The primary element of Alternative 2 is the consolidation and capping of contaminated material into the existing landfills. Three alternatives were considered to present options for addressing the Outlying Areas within OU1. Alternative 2A includes the consolidation of Outlying Areas within OU1 and perimeter areas into the Bryant HRDLs/FRDLs and Monarch HRDL. Approximately 320,000 yd^3 of contaminated materials will be excavated in Alternative 2A, plus an additional 30,000 yd^3 to create a clean setback from Portage Creek. Alternative 2A is shown in Figure 2A.

Alternative 2B includes the consolidation of the Outlying Areas located within OU1, the Monarch HRDL and the perimeter area around the Bryant HRDLs/FRDLs into the Bryant HRDLs/FRDLs Landfill. Approximately 460,000 yd^3 of contaminated materials will be excavated in Alternative 2B, plus an additional 19,000 yd^3 to create a clean setback from Portage Creek. Alternative 2B is shown in Figure 4-2B.

Alternative 2C includes the consolidation of materials with PCB concentrations of 500 mg/kg or less from the Outlying Areas located within OU1, the Monarch HRDL, and the perimeter area around the Bryant HRDLs/FRDLs into the Bryant HRDLs/FRDLs Landfill. An estimated total 460,000 yd^3 of contaminated material will be excavated in Alternative 2C, plus an additional 19,000 yd^3 to create a clean set back from Portage Creek. Excavated materials with PCB concentrations greater than 500 mg/kg will be transported offsite for incineration. Of the 460,000 yd^3, an estimated 15,000 yd^3 of material will contain PCB concentrations above 500 mg/kg and will be transported offsite for incineration. The remaining 445,000 yd^3 of material will be consolidated into the Bryant HRDLs/FRDLs Landfill and capped. Alternative 2C is shown with Alternative 2B in Figure 4-2B.

The Alternative 2 options include covering the landfills after consolidation with an engineered landfill cap. For Alternative 2A, the landfill cap will be approximately 48 acres, and for Alternatives 2B and 2C, the landfill cap will be approximately 43 acres. The approach would also include long-term inspections and maintenance of the engineered barriers, monitoring of landfill gas and groundwater, and institutional controls. Groundwater monitoring implementation and costs are included in the assessment for implementing Alternative 2 options. The Alternative 2 options can include groundwater subalternatives for collection and treatment. Groundwater collection and treatment and slurry wall installation and costs are assessed separately in Section 5.3.

Alternative 2 options require institutional controls to restrict activities that could either damage the remedy or allow for exposure to contaminated material left in place (example, under buildings). At the OU1 property, restrictive covenants, prohibiting the installation of drinking water wells and preventing activities that could compromise the landfill cap would be required. If contaminated material from OU1 is left in place at Outlying Areas, institutional controls in the form of restrictive covenants would be required to prohibit activities that would cause exposure to contaminated material.

5.2.1 Overall Protection of Human Health and the Environment

Alternative 2 options are expected to be effective remedies for protection of human health and the environment. The Alternative 2 options would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing COCs above the relevant PRGs. Implementation of Alternative 2 options would also achieve RAO 2, since materials with COC concentrations above relevant PRGs would be covered with an engineered cap. The cap will mitigate the potential for migration to Portage Creek or onto adjacent properties by erosion. Alternative 2 options will achieve RAO 3 by preventing surface water infiltration through the waste. In order to confirm that RAO 3 has been achieved, a long-term groundwater monitoring program would be implemented. Institutional controls, monitoring, and maintenance of the Bryant HRDLs/FRDLs Landfills are critical components for maintaining protectiveness over time.

Alternative 2 would also include a long-term inspection and maintenance program of the Bryant HRDLs/FRDLs and, if implemented under Alternative 2A, the Monarch HRDL. The alternative also includes a long-term monitoring program for the management of landfill gas. Groundwater monitoring and subalternatives for groundwater collection and treatment and installation of a slurry wall are evaluated in Section 5.3. Groundwater monitoring and long-term inspection and maintenance activities would be conducted to assess whether the remedy is functioning as intended and to ensure that GSI criteria are met.

Alternative 2C is slightly more protective of human health and the environment since some of the highest concentration materials are removed from the site. However, the exposure pathways for the wastes are incomplete under all three of the Alternative 2 options, meeting the RAOs. Overall protection of human health and the environment is expected to be achieved upon completion of the consolidation activities and installation of the engineered cap (anticipated to take 2 years).

5.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 2 would achieve ARARs. Specific ARARs are summarized as follows:

- **Clean Water Act.** Section 404 of the Clean Water Act applies to the discharge of dredge and fill material into the waters of the United States, including wetlands. Superfund policy is to require a minimum of one acre of wetlands mitigation for each acre of wetland filled. (See "Considering Wetlands at CERCLA Sites" OSWER 9280.0-03.) Alternative 2 will comply with the Federal Mitigation Rule set forth at C*ompensatory Mitigation for Losses of Aquatic Resources; Final Rule* 40 CFR § 230.94(c)(2-14) because at least 1 acre of wetlands will be mitigated for each acre of wetland filled and a restrictive covenant will be implemented to maintain the wetland area. Alternative 2 will achieve this ARAR.

- **Part 201, Environmental Remediation, of NREPA, 1994 PA 451, as amended (Part 201).** Alternative 2 would reduce the potential for exposure to COC-containing residuals/soils, address the potential migration of COC-contaminated material, and achieve a degree of protectiveness for the property, as required in Part 201, Sections 20120a, 20120b, and 20120e. Groundwater monitoring data (2003) showed that groundwater was below generic GSI criteria under MCL 324.20120e between the waste management boundary and Portage Creek. Alternative 2 includes installation of additional groundwater monitoring wells to monitor the performance of the remedy and demonstrate compliance with GSI criteria at and near Portage Creek under

MCL 324.20120e. Alternative 2 would satisfy the requirements for long-term monitoring and achieve the requirement to restrict future land use. This alternative includes restrictive covenants for areas that exceed the cleanup level for residential use and for containment areas as required in MCL 324.20114c.

- **Part 31, Water Resources Protection of NREPA, 1994, PA 451, as amended (Part 31).** In accordance with the federal Water Pollution Control Act and the federal Clean Water Act, this state ARAR establishes state criteria for rivers, creeks, and floodplain areas, to protect aquatic life and human health. It also establishes water quality standards and monitoring requirements for discharge effluents including stormwater and venting groundwater, specifying standards for several water quality parameters, including COCs. Alternative 2 is required to meet the GSI requirements for venting groundwater under MCL 324.20120e, and thus is expected to meet the groundwater venting requirements for Part 31.
- **Part 55, Air Pollution Control, of NREPA (Part 55).** This state ARAR establishes the requirements for air emissions. Current COC emissions are within acceptable limits. Excavation of COC-containing materials and disturbance of the current landfill surfaces and perimeters during construction could result in increased air emissions. Therefore, best management practices should be implemented to minimize airborne emissions during construction and remedy implementation to mitigate unacceptable air emissions. A health and safety plan would need to be developed to monitor emissions, prevent worker and community exposure, and confirm compliance with this ARAR.
- **Michigan Public Act 451, Part 303—Wetlands Protection.** This ARAR establishes rules regarding wetland uses. Alternative 2 is anticipated to comply with this ARAR.
- **Part 91, Soil Erosion and Sedimentation Control of NREPA, 1994 PA 451, as amended (Part 91).** This ARAR establishes requirements to minimize soil erosion and sedimentation. The ARAR requires that an “earth change” (excavation, filling, or grading) be designed, constructed, and completed in a manner that limits the exposed area of any disturbed land for the shortest possible period of time, as determined by the local enforcing agency. It also requires the design of temporary or permanent control measures constructed for the conveyance of water around, through, or from the earth change area to limit the water flow to a non-erosive velocity. The ARAR requires installation and maintenance of temporary silt fences or other structures as necessary to minimize erosion and sedimentation during construction activities. Alternative 2 will comply with this ARAR by preparing and properly implementing a soil erosion and sedimentation control plan in accordance with Part 91.
- **TSCA, 40 CFR § 761.61.** This ARAR applies to the cleanup and disposal of PCB Remediation Waste. Alternative 2 meets the standards of 40 CFR § 761.50(b)(3)(i)(A) for remediation and will not pose an unreasonable risk of injury to health or the environment pursuant to 40 CFR § 761.61(c) for the following reasons: (1) This alternative will meet the PCB PRGs set forth in Table 2-3 for surface soils, subsurface soils, sediments, and groundwater, and (2) a cap will be constructed over the landfill to eliminate direct contact hazards and minimize infiltration of precipitation through the landfill and subsequent migration of residuals or leachate from the landfill into the adjacent areas. See discussion under 5.2.1 and 5.2.3 concerning how the cap will achieve RAOs and be effective over the long term. The cap exceeds the impermeability requirements set forth in 40 CFR §761.75(b)(ii) (referenced in 40 CFR § 761.61(a)(7)) through the inclusion of a 30-millimeter polyvinyl chloride FML or equivalent with a permeability less than 1×10^{-10} centimeters per second). This is more protective than the 1×10^{-7} centimeters per second permeability requirement of 40 CFR § 761.61(7) and by reference 40 CFR 761.75(b)(ii). The performance criteria in 40 CFR §761.75(b)(iii) through (v) are specific to soil caps and are not relevant with the use of a FML. In addition, this alternative includes restrictive covenants incorporating the restrictions set forth in 40 CFR 761.61(a)(8). Alternative 2C would also use a TSCA-permitted incineration facility.
- **Michigan Public Act 451, Part 115—Solid Waste Management.** The Part 115 rules promulgated for the cover design, groundwater monitoring, hydrogeologic monitoring, and construction quality control requirements for a Type III sanitary landfill would be relevant and appropriate for those alternatives that cap material in place

at OU1. Alternative 2 will comply with this ARAR by including the cap layers and post-construction monitoring required under Part 115 in the cap for the landfills

5.2.3 Long-term Effectiveness and Permanence

Implementation of Alternative 2 would generally be expected to achieve the RAOs for OU1, be effective over the long term, and maintain protection of human health and the environment after the after the remedial action has been completed. Isolation of COC-containing materials under an engineered cap is a proven and reliable technology to prevent human and ecological exposure. Capping would mitigate the potential for direct contact and COC-containing materials to migrate by air emissions, wind-blown particles, erosion, or surface water runoff into Portage Creek or onto adjacent properties, RAOs 1 and 2. Capping would minimize infiltration through the waste, reducing potential impacts to groundwater and surface water, RAO 3. Implementation of institutional controls, long-term monitoring, and maintenance would allow for the long-term effectiveness and permanence of the engineered cap. The potential for failure of the engineered cap is low, a clean setback and stabilized stream banks will reduce the potential for Portage Creek to erode into the landfill. O&M activities would effectively identify future maintenance needs, and institutional controls would prohibit activities that could damage the cap. The details of long-term monitoring and maintenance would be developed during the RD and compiled into an O&M program. Groundwater monitoring and collection and treatment subalternatives are evaluated in Section 5.3.

Alternative 2, along with effective implementation of institutional controls, would effectively reduce risks over the long term, and the monitoring components would provide mechanisms to assess whether the remedy is performing in a manner that satisfies the RAOs over time. The treatment component to Alternative 2C only slightly increases protectiveness as the PCBs are largely immobile already.

Alternatives 2B and 2C provide a smaller footprint for the remaining landfill areas than Alternative 2A. A smaller footprint decreases the area requiring O&M and reduces the number of monitoring well locations needed for monitoring.

Future use of OU1 and potential long-term reuse issues would be addressed through monitoring and institutional controls, including restrictive covenants, and access restrictions, such as signage and fencing. Alternative 2 would allow for redevelopment, both commercial and recreational in the area away from the landfill. Limited reuse scenarios are also possible on the landfill itself. Relocation of the Monarch HRDL could open an additional 6.8 acres to recreational use in the floodplain.

5.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 2A and 2B use containment to reduce the mobility of COC-containing materials without treatment. Alternative 2C also uses treatment for excavated soils with PCB concentrations above 500 mg/kg. Treatment is most important for COCs that are mobile in the environment. As discussed in the RI report and summarized in Sections 1.5.1 and 2.3.1 of this report, PCBs tend to be relatively immobile in the environment, and at OU1 are most prone to migration where they are exposed to erosion. Based on the combined effects of high affinity for PCBs to adhere to the residual and the low hydraulic conductivity, it is understood that PCBs do not migrate significantly from the residual material. In situ treatment to reduce mobility (stabilization) would be of little benefit since PCB concentrations in groundwater do not exceed criteria with the exception of wells screened within or immediately adjacent to the residuals. Stabilization would likely also cause a significant increase in volume of waste due to the addition of solidifying agents. As a result, the isolation of PCB-containing materials in place through consolidation beneath an engineered cap is expected to effectively address the mobility of PCBs and other COCs associated with potential migration by erosion. Treatment to reduce the volume or toxicity is addressed in Alternative 2C through incineration of a portion of the PCB-containing materials. Only the materials with concentrations above 500 mg/kg were considered for incineration due to the high cost and limited incinerators permitted to accept this waste.

5.2.5 Short-term Effectiveness

Alternative 2 provides an acceptable degree of short-term effectiveness. There is the potential for a short-term increase in COC exposure to workers due to potential disturbance of COC-containing residuals as part of site preparation and implementation of the alternative; however, compliance with dust control procedures (appropriately wetting materials) and proper health and safety procedures (for example, monitoring and use of personal protective equipment as described in a health and safety plan) to be developed during remedial design would effectively mitigate the short-term impacts and protect onsite workers from hazards during construction (for example, working around heavy equipment).

The primary short-term impacts to the community include increased noise, the potential for dust-borne releases, and increased traffic. The potential for noise issues and dust-borne releases is most significant with the implementation of Alternative 2C since that alternative includes the additional work and construction duration for characterization and segregation of materials over 500 mg/kg for offsite transport and incineration. In Alternative 2A, the Monarch HRDL would be capped in place and would not be consolidated into the Bryant HRDLs/FRDLs, Western Disposal Area, and Former Type III Landfill. After excavation and consolidation, truck traffic in local residential neighborhoods would increase throughout the duration of the project, since materials for the engineered cap would be hauled to OU1. Under Alternative 2 options, materials excavated from the Outlying Areas would be trucked to the Bryant HRDLs/FRDLs and/or Monarch HRDL, and clean fill would be hauled in to fill the excavations. An estimated 39,000 truck trips are estimated to implement Alternative 2A, while over 49,000 truck trips are estimated to implement Alternative 2B. Alternative 2C also incurs increased short-term risks associated with offsite transport. It is anticipated that an additional 1,000 truck trips are required to haul the most highly contaminated materials approximately 40 miles to an intermodal facility where they would be loaded onto rail for transport to the incineration facility. The number of TSCA-permitted incinerators is very limited, so the rail transport could be 1,200 miles or more.

The removal of materials beneath the Alcott Street and Goodwill parking lots would have significant short-term impacts to neighboring properties/property owners. The excavations at these locations may reach 15 to 20 feet below grade or more, and are expected to require benching and/or sheet pile to allow removal to target depths. The installation and removal of sheet pile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants. Additional short-term environmental impacts are associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet.

Reasonable and appropriate controls (for example, silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of OU1 to mitigate impacts to the aquatic environment. Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate). The estimated duration to complete Alternative 2 is approximately 2 years. The installation of the engineered caps would be conducted during the standard Michigan construction season, which is typically early April through the end of October, weather-dependent.

5.2.6 Implementability

Implementation of Alternative 2 includes the following major components: excavation and consolidation, construction of engineered caps, installation of a stormwater management system, landfill gas monitoring, restoration, and O&M activities, groundwater monitoring, and the implementation of institutional controls. Groundwater collection and treatment or slurry wall installation are considered as subalternatives to groundwater monitoring and are evaluated in Section 5.3. The process options incorporated into this alternative are proven remedial options and have been implemented successfully on environmental cleanup projects throughout the country. Technologies for the installations of engineered caps are well-established, widely applied, and are proven to be reliable over long periods of time at sites of similar size and characteristics.

The excavation depths of the Outlying Areas are more complicated than the periphery of the Bryant HRDLs/FRDLs and/or Monarch HRDLs. Excavations at the Alcott Street and Goodwill parking lots could extend as deep as 15 to 20 feet below the ground surface. Given this depth and the adjacent buildings, the excavations would need to be stabilized with temporary steel sheeting. Special implementation methods will be required to drive the sheets while minimizing the potential for damage to the adjacent structure, for example, trenching and predrilling, and pile driving using low vibratory methods may be used to minimize impacts. Crack, vibration, and settlement monitoring will be required to verify sheet pile installation is not causing damage to adjacent properties.

Excavating to a depth of 15 to 20 feet below the ground surface significantly increases the likelihood of encountering groundwater—as a result, supplemental engineering controls would be necessary to manage groundwater in the saturated fill. Such engineering controls would likely include a combination of excavation reinforcement (such as sheeting), dewatering, and soil stabilization. If a significant head differential exists between the groundwater table and the base of the excavation, a potential for creating hydrostatic pressure at the base of the excavation exists. Concerns relating to hydrostatic pressure may be minimized through engineering controls such as lengthening the flow path (for example, if sheeting is used, increasing the embedment depth) and installing piezometers for monitoring vertical hydraulic gradients. While such groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable. The offsite excavations are assumed to be completed with conventional earth-moving equipment. The periphery excavation and consolidation activities at the Bryant HRDLs/FRDLs and/or Monarch HRDLs are also implementable using conventional earth-moving equipment. Dewatering and erosion and sedimentation controls, such as silt fence, would also be required around wetland areas.

Support services and sufficient quantities of construction materials are expected to be readily available, and qualified commercial contractors are available locally to perform the work. Since OU1 is part of a CERCLA site, permits are not required for onsite activities; however, meeting the substantive applicable requirements of federal and state regulations is required.

Alternative 2C is the least implementable due to the characterization and segregation that will be required for off-site incineration and the limited number of TSCA-permitted incinerators. With an estimated 15,000 yd^3 of material and a minimum transport distance of approximately 1,200 miles to a TSCA-permitted incinerator, trucking is not a feasible alternative. The wastes would likely need to be loaded into intermodal roll-off containers, transported by truck to an intermodal transfer facility, and transferred to rail.

Implementation of a sitewide groundwater monitoring program requires the installation of monitoring wells and sampling. Sitewide monitoring programs have been implemented successfully on cleanup projects throughout the Kalamazoo River OUs and across the country.

Institutional controls at the OU1 property should be easily implemented by Lyondell, the bankruptcy Trustee. It will likely be more challenging to implement institutional controls at the Goodwill property; however, they are implementable as evidenced by the existing institutional controls there.

5.2.7 Cost

Costs for Alternative 2 are associated with the following construction activities: project-area preparation, excavation and consolidation, installation of the engineered cap, stormwater management, restoration, and long-term monitoring and maintenance. Costs for Alternative 2 include groundwater monitoring in the base remedy cost.

The estimated costs associated with the implementation of Alternatives 2A, 2B, and 2C are presented in Tables 5-2, 5-3, and 5-4, respectively.

The total estimated capital cost of implementing Alternative 2A is $36 million, and the total estimated O&M cost is $7.4 million. The total estimated periodic cost for 5-year reviews is $120,000. The total estimated 30-year present-worth cost associated with implementation of Alternative 2A is $43 million.

The total estimated capital cost of implementation of Alternative 2B is $36 million, and the total estimated O&M cost is $5.5 million. The total estimated periodic cost for 5-year reviews is $120,000. The total estimated 30-year present-worth cost associated with implementation of Alternative 2B is $41 million.

The total estimated capital cost of implementation of Alternative 2C is $57 million, and the estimated O&M cost is $5.5 million. The total estimated periodic cost for 5-year reviews is $120,000. The total estimated 30-year present-worth cost associated with implementation of Alternative 2C is $62 million.

The total costs for Alternatives 2A and 2B are similar, $43 million versus $41 million. While Alternative 2B requires excavation of an additional 129,000 yd^3 of contaminated soil and residuals, the cost is offset by the smaller area requiring capping in Alternative 2B versus 2A. Alternative 2C is significantly increased (total of $62 million) as a result of the offsite transportation and incineration of 15,000 yd^3 of material.

5.3 Alternative 2—Subalternatives (i) and (ii)

Groundwater monitoring is included in Alternative 2 options. The purpose of the monitoring program will be to monitor the performance of the remedy and to allow for the ongoing evaluation of whether Alternative 2 options meet RAO 3.

The following are primary elements of the groundwater subalternatives: (i) groundwater collection and treatment for the hydraulic containment and control of impacted groundwater within OU1, and (ii) containment through installation of a ground slurry wall (approximately 3,000 linear feet) around the perimeter of the Bryant HRDLs/FRDLs, and under Alternative 2A, the Monarch HRDL, along with hydraulic containment/control assessed.

5.3.1 Overall Protection of Human Health and the Environment

Groundwater monitoring will be used to verify the capping remedies are performing as expected, minimizing surface water infiltration, and that the COC-contaminated material at OU1 is not impacting groundwater, causing groundwater with concentrations exceeding the PRGs to migrate to Portage Creek. Monitoring is included as a component of Alternative 2 options. Alternative 2 will achieve RAO 3 by preventing surface water infiltration through the waste. The groundwater monitoring program monitors the performance of the remedy and compliance with RAO 3.

Subalternative (i), groundwater collection and treatment, and subalternative (ii), slurry wall with groundwater collection and treatment, are both expected to be effective remedies for the protection of human health and the environment from impacted groundwater by reducing the potential for PCB-contaminated material from impacting groundwater or surface water that migrates into Portage Creek or onto offsite properties.

The use of only subalternative (i) is expected to achieve RAO 3 through the collection and treatment of groundwater that may be impacted by COC-containing material at OU1. The use of subalternative (ii), slurry wall with groundwater collection and treatment, will allow for groundwater gradients to be manipulated, reversing groundwater flow from Portage Creek toward the fill area.

5.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Groundwater subalternatives (i) and (ii) would be implemented in conjunction with Alternative 2 options if needed; therefore, they would achieve the ARARs summarized in Section 5.2.2.

5.3.3 Long-term Effectiveness and Permanence

Provided that they are maintained, implementation of groundwater subalternatives (i) and (ii) would generally be expected to achieve the RAO 3 for OU1. Both subalternatives would be effective over the long term, and would maintain protection of human health and the environment after the RAOs have been achieved. Hydraulic containment is a proven and reliable technology to prevent human and ecological exposure by capturing impacted groundwater before migrating offsite.

The long-term effectiveness of the cap and/or hydraulic containment contingencies would be evaluated through the long-term monitoring program implemented under Alternative 2 options. With proper maintenance, the potential for failure of the hydraulic containment or isolation and hydraulic containment contingencies is low. Currently, a sheet pile wall exists along a portion of the Bryant HRDLs/FRDLs, and a groundwater collection system is currently in place to maintain historical water levels at OU1.

Subalternative (i), groundwater collection and treatment, could be abandoned simply if monitoring indicated that hydraulic containment was no longer needed. Subalternative (ii), construction of a slurry wall, is expected to cause groundwater mounding upgradient of its location. This would require the hydraulic controls be operated as long as the isolation wall is in place. Removal of the slurry wall is an expensive undertaking in the post-closure period. It should be noted that the existing sheet pile wall is identified for removal or modification in this and other alternatives to allow for groundwater flow to the creek. The use of subalternative (ii) would reestablish an impermeable barrier that is proposed for removal in most alternatives.

Installation of the slurry wall under subalternative (ii) may create long-term issues. One of the reasons for the removal of the sheet pile wall is to create natural groundwater flow towards the creek. Installation of a slurry wall downgradient from the landfills towards the creek would again create an impermeable barrier. The barrier would create mounding of groundwater underneath the landfill and cause the creation of preferential pathways for the groundwater around the slurry wall along the edges of the system without groundwater collection and treatment.

The details of long-term monitoring and maintenance for subalternatives (i) and (ii) would be developed during the RD and compiled into an O&M program. Groundwater treatment subalternatives (i) and (ii) would effectively reduce the risk of offsite impacted groundwater migration over the long term, and the monitoring component would provide a mechanism to assess whether the contingencies are performing in a manner that satisfies RAO 3 over time.

5.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Subalternatives (i) and (ii) address the federal statutory preference for a remedy that employ treatment technologies by providing treatment to limited amounts of groundwater prior to discharge. The treatment reduces the volume of COCs in groundwater, if present. The hydraulic containment system would include treatment of extracted groundwater prior to discharge, thereby reducing the volume of COCs, if present in the groundwater.

5.3.5 Short-term Effectiveness

Minimal exposure is associated with the installation and later sampling of groundwater wells for monitoring. Operation of the groundwater collection and treatment system will also provide an acceptable degree of short-term effectiveness. Minimal exposure is associated with the operation of the system. Some disturbance of waste could be expected during well or trench installation. There is a greater potential of short-term exposure risk to workers due to potential disturbance of impacted residuals as part of installation of a hydraulic containment system around the landfills.

Soil and groundwater management and proper health and safety procedures (for example, monitoring and use of personal protective equipment as described in the health and safety plan) to be developed during remedial design would effectively mitigate the short-term impacts and protect onsite workers from exposure to hazards during construction associated with either of the subalternatives.

The primary short-term impacts from implementation of groundwater treatment subalternatives (i) and (ii) to the community include increased noise and increased traffic. Truck traffic in local residential neighborhoods would increase throughout the duration of the project, since materials for the additional groundwater treatment system and, if selected, slurry wall (ii), would be hauled to OU1. Additional short-term environmental impacts are associated with the potential for offsite migration due to incidental releases to Portage Creek during installation of the additional hydraulic containment system or slurry wall. Reasonable and appropriate controls (for example, silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of the Bryant HRDL, Panelyte Marsh, and Former Monarch Raceway Channel to mitigate impacts to the aquatic environment. Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate). The estimated duration to complete groundwater monitoring is included in Alternative 2 options. The estimated duration to complete subalternative (i) is 2 months, and subalternative (ii) is 4 months.

5.3.6 Implementability

The groundwater collection and treatment subalternative (i) includes the following component: installation of extraction wells and/or collection trenches at the Bryant HRDLs/FRDLs and, if Alternative 2A is selected, Monarch HRDL. O&M of the groundwater treatment system would be necessary if subalternative (i) was implemented as part of any Alternative 2 option.

Implementation of subalternative (ii) would include the following components: installation of a slurry wall around the Bryant HRDLs/FRDLs and, if Alternative 2A is selected, Monarch HRDLs; installation of extraction wells and/or collection trenches to prevent groundwater mounding; O&M of the groundwater collection and treatment system; and long-term maintenance and monitoring of the slurry wall.

The process options incorporated into the groundwater subalternatives (i) and (ii) are proven remedial technologies and have been implemented successfully on environmental cleanup projects throughout the country. Groundwater monitoring planned under Alternative 2 options would continue with either subalternative to verify the system is performing as designed.

Installation of the slurry wall under subalternative (ii) may create long-term issues. One of the reasons for the removal of the sheet pile wall under this and other alternatives is to create natural groundwater flow towards the creek. Installation of a slurry wall downgradient from the landfills towards the creek would again create an impermeable barrier. The barrier would create mounding of groundwater underneath the landfill and cause the creation of preferential pathways for the groundwater around the slurry wall along the edges of the system if the groundwater collection and treatment system were shut down.

Support services and sufficient quantities of construction materials are expected to be readily available for each of the subalternatives. Since OU1 is part of a CERCLA site, permits are not required for onsite activities; however, meeting the substantive applicable requirements of federal and state regulations is required.

5.3.7 Cost

Costs for groundwater monitoring are included in cost estimates for Alternative 2 options. Monitoring would be a required component of both subalternatives (i) and (ii) and would not change significantly if either of the groundwater subalternatives were selected.

The estimated costs associated with the implementation of subalternative (i) groundwater collection and treatment and (ii) slurry wall installation for Alternative 2A are presented in Tables 5-5 and 5-6, respectively.

The total estimated capital cost of implementing subalternative (i) for Alternative 2A is $1.6 million, and the total estimated O&M cost is $3.1 million. The total estimated 30-year present-worth cost associated with implementation of subalternative (i) for Alternative 2A is $4.6 million.

The total estimated capital cost of implementing subalternative (ii) for Alternative 2A is $10 million, and the total estimated O&M cost is $3.1 million. The total estimated 30-year present-worth cost associated with implementation of subalternative (ii) for Alternative 2A is $13 million.

The estimated costs associated with the implementation of subalternative (i) groundwater collection and treatment and (ii) slurry wall installation for Alternative 2B and 2C are presented in Tables 5-7 and 5-8, respectively.

If Alternative 2B or 2C is selected, the total estimated capital cost of implementing subalternative (i) is $1.5 million, and the total estimated O&M cost is $3.1 million. The total estimated 30-year present-worth cost associated with implementation of subalternative (i) for Alternative 2B or 2C is $4.5 million.

The total estimated capital cost of implementing subalternative (ii) for Alternative 2B or 2C is $8.6 million, and the total estimated O&M cost is $3.1 million. The total estimated 30-year present-worth cost associated with implementation of subalternative (ii) for Alternative 2B or 2C is $12 million.

5.4 Alternative 3—Total Removal and Offsite Disposal

Alternative 3 includes excavation and offsite disposal of materials exceeding PRGs for OU1 COCs. Materials would be excavated from the Former Operational Areas; the Bryant HRDLs/FRDLs; the areas that lie close to Portage Creek, the targeted portions of Panelyte Marsh, Panelyte Property, and Conrail Property; the Outlying Areas (other than the portion of the Goodwill property covered by buildings); and the areas in the periphery of the Former Operational Areas near adjacent properties (Figure 4-3). After removal, excavation areas would be backfilled with clean material, covered with topsoil, and revegetated with native plants and grasses. This alternative also includes the removal of 2,600 linear feet of sheet pile along the western bank of Portage Creek. No other O&M activities or institutional controls would be necessary.

It may not be possible to excavate all of the material at the Goodwill property. If, due to practicability, contaminated material from OU1 is left in place at Outlying Areas, institutional controls in the form of restrictive covenants would be required to prohibit activities that would cause exposure to contaminated material.
If material is left at the Goodwill property, a groundwater subalternative (Section 5.3) would be required. For the purposes of this evaluation, it is assumed that all material exceeding PRGs can be removed, and institutional controls and groundwater monitoring would not be required.

5.4.1 Overall Protection of Human Health and the Environment

Alternative 3 would be an effective long-term remedy for OU1—it would eliminate the potential for direct contact with materials onsite above PRGs. In the offsite outlying areas, the potential for human and ecological receptors to be exposed to materials containing COCs above the relevant PRGs would also be eliminated. There would be no materials above the OU1 PRGs to migrate into Portage Creek or onto offsite properties. The actions would be prevented through excavation and offsite disposal. Since no materials with COCs above OU1 PRGs would be left in place onsite, no monitoring or maintenance activities would be necessary to maintain protectiveness over time, unless material must be left in place below the Goodwill building; in which case, monitoring and maintenance would be required for that limited area.

Total removal would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing COCs above the relevant PRGs, by excavation and offsite disposal. Implementation of Alternative 3 would also achieve RAO 2 since contaminated material would be removed from OU1, thus eliminating the potential for contaminated material to be transported to Portage Creek or onto adjacent properties. The removal of materials with COC concentrations above the relevant PRGs would eliminate any issues with surface water infiltration and subsurface groundwater migration. Alternative 3 would achieve RAO 3 since the source material would be removed. Since the sources would be removed, there would be no need for a long-term groundwater monitoring program, unless material must be left in place below the Goodwill building.

Overall, protection of human health and the environment is expected to be achieved upon completion of the excavation and disposal activities (anticipated to take 5 years). There would be no need for institutional controls to be put in place to maintain effectiveness over time.

5.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 3 would achieve compliance with ARARs as follows:

- **Clean Water Act.** Section 404 of the Clean Water Act applies to the discharge of dredge and fill material into the waters of the United States, including wetlands. Superfund policy is to require a minimum of one acre of wetlands mitigation for each acre of wetland filled. (See "Considering Wetlands at CERCLA Sites" OSWER 9280.0-03.) Alternative 3 will comply with the Federal Mitigation Rule set forth at C*ompensatory Mitigation for Losses of Aquatic Resources; Final Rule* 40 CFR § 230.94(c)(2-14) because at least one acre of wetlands will be mitigated for each acre of wetland filled and a restrictive covenant will be implemented to maintain the wetland area.
- Part 201, Environmental Remediation, of NREPA, 1994 PA 451, as amended (Part 201). This alternative will meet the cleanup standards set forth in Part 201.
- **Part 31, Water Resources Protection of NREPA, 1994, PA 451, as amended (Part 31).** This Alternative will achieve this ARAR. In accordance with the federal Water Pollution Control Act and the federal Clean Water Act, this state ARAR establishes state criteria for rivers, creeks, and floodplain areas, to protect aquatic life and human health. It also establishes water quality standards and monitoring requirements for discharge effluents including stormwater and venting groundwater, specifying standards for several water quality parameters, including COCs.

- **Part 55, Air Pollution Control, of NREPA (Part 55). This state ARAR establishes** the requirements for air emissions. Current COC emissions are within acceptable limits. Excavation of COC-containing materials and disturbance of the current landfill sur*faces and perimeters during construction could result in increased* air emissions. Therefore, best management practices should be implemented to minimize airborne emissions during construction and remedy implementation to mitigate unacceptable air emissions. A health and safety plan would need to be developed to monitor emissions, prevent worker and community exposure, and confirm compliance with this ARAR.
- **Michigan Public Act 451, Part 303—Wetlands Protection.** This ARAR establishes rules regarding wetland uses. This Alternative is anticipated to comply with this ARAR. See discussion in Section 5.2.2.
- **Part 91, Soil Erosion and Sedimentation Control of NREPA, 1994 PA 451, as amended (Part 91).** This ARAR establishes requirements to minimize soil erosion and sedimentation. The ARAR requires that an "earth change" (excavation, filling, or grading) be designed, constructed, and completed in a manner that limits the exposed area of any disturbed land for the shortest possible period of time, as determined by the local enforcing agency. It also requires the design of temporary or permanent control measures constructed for the conveyance of water around, through, or from the earth change area to limit the water flow to a non-erosive velocity. The ARAR requires installation and maintenance of temporary silt fences or other structures as necessary to minimize erosion and sedimentation during construction activities. This alternative will comply with this ARAR by preparing and properly implementing a soil erosion and sedimentation control plan in accordance with Part 91.
- **TSCA, 40 CFR § 761.61.** This ARAR applies to the cleanup and disposal of PCB Remediation Waste. Alternative 3 meets the standards of 40 CFR § 761.50(b)(3)(i)(A) for remediation and will not pose an unreasonable risk of injury to health or the environment pursuant to 40 CFR § 761.61(c), The alternative will meet the PRGs set forth in Table 2-3 for surface soils, subsurface soils, sediments and groundwater. Excavated materials that contain PCB concentrations and are intended for offsite disposal will comply with 40 CFR § 761.61(b)(2)(1).

5.4.3 Long-term Effectiveness and Permanence

The primary components incorporated into Alternative 3—excavation, offsite disposal, and immobilization—are proven and reliable, and would be expected to provide long-term protection of human health and the environment after the remedial action has been completed. After the construction phase is over, sources of COCs exceeding OU1 PRGs in the Operations Area and in the Outlying Areas will be permanently removed. Institutional controls (for example, restrictive covenants and enforcement tools) would be implemented for the areas where COCs may be left in place or to limit future land use. The alternative would eliminate the potential for source materials to migrate by air emissions, wind-blown particles, erosion, or surface water runoff into Portage Creek or onto adjacent properties. Stability of OU1 would be improved since the final surface would be graded to a stable repose above the water table, covered with topsoil, and vegetated with native plants and grasses. Outlying Areas would be restored to the original grade and re-vegetated.

A long-term monitoring and maintenance program to monitor the long-term effectiveness and permanence of the approach would also not be required since materials above OU1 PRGs have been removed offsite. There is no potential for failure of the remedy over the long term. The area would be available for redevelopment for either commercial or recreational use. Restrictive covenants would still be required to prohibit high occupancy of commercial areas.

Because all of the material above PRGs would be removed from OU1 under Alternative 3, there would be no need to continue the groundwater monitoring program. The potential for groundwater exceeding applicable criteria to migrate to Portage Creek or offsite would be eliminated. The alternative also includes the removal of the existing sheet pile along the western bank of Portage Creek. As a result, there would be no risk of failure of the sheet pile or need for maintenance. Alternative 3 would effectively eliminate OU-related risks over the long term.

5.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 reduces the volume of contaminated soils onsite and the mobility by disposing of the materials in offsite disposal facilities. However, this option does not include treatment or result in overall reductions of toxicity, mobility, or volume of contaminated soils. For the FS, it has been assumed that the addition of a stabilizing agent will not be required to address free liquids prior to transport offsite.

5.4.5 Short-term Effectiveness

Implementation of Alternative 3 would present increased short-term risks due to issues associated with health risks to onsite workers, impacts to the community, duration of the project, and environmental impacts. The potential health risks to onsite remediation workers are due to short-term increases in COC exposure during site preparation and implementation (a result of either direct exposure or by dust-borne releases during excavation and handling of impacted materials). While this risk could be mitigated through the use of appropriate health and safety practices and by compliance with a health and safety plan, the volume of materials to be handled (1,600,000 yd^3) and the area of disturbance (a total of 65 acres) increase the chances of exposure. In addition, the number of work hours spent onsite around heavy equipment would be significant over a 5-year project, increasing the risk of an accident as compared to an option where fewer hours are spent in active construction activities.

The more significant short-term considerations associated with Alternative 3 are related to impacts to the community and the duration of those impacts—implementation is expected to take 5 years. There will be noise and increased traffic during implementation as well as potentially significant wear and tear on local roads. In addition, down-wind areas such as the residential properties may be subject to an increased potential for dust-borne releases. Excavation work is not confined to the warmer months, so excavation will be carried out year-round, 5 days per week. Over the course of the project, an average of 115 trucks per day would travel in and out of OU1 over a 260-day work year (5 work days per week) to transport excavated material for offsite disposal and haul clean fill to the excavated areas. An estimated 150,000 truck trips to and from OU1 would be necessary to implement Alternative 3.

There would be short-term environmental impacts associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek given that 65 acres will be disturbed during the implementation of Alternative 3. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet. However, because the entire landfill would be excavated under this alternative, including 1,600,000 yd^3 of residuals, there is an increased potential for dust-borne releases. Reasonable and appropriate controls (for example, silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of OU1 to mitigate impacts to these environments.

The removal of materials exceeding OU1 PRGs beneath the Alcott Street and Goodwill parking lots would cause short-term impacts to neighboring properties/property owners. The excavations at the locations may reach 20 feet or more below grade, and are expected to require benching and/or sheet pile to allow removal to target depths. The installation and removal of sheet pile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants. Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

5.4.6 Implementability

Implementation of Alternative 3 includes the following major components: excavation, offsite disposal, and restoration. The components are proven and have been used successfully in numerous other environmental cleanup projects. Complete removal of materials containing COCs above the relevant PRGs is proven to be reliable. The disposal of impacted materials in a licensed disposal facility could present significant administrative challenges. There is a limited number of solid waste landfills in southwest Michigan. Available disposal facilities may have restrictions as to the rate at which they will accept waste material given the limitations of the size and configuration of their operations.

Further, among the available solid waste facilities there may be limited disposal capacity to place the PCB-containing materials. The TCRA completed at the former Plainwell Impoundment in Plainwell, Michigan, between 2007 and

2009 included the removal and offsite disposal of 130,000 yd^3 of PCB-containing soils and sediments at three solid waste landfills in the region—two were used for non-TSCA waste, and the third was used for TSCA waste. At the time of the TCRA, the landfills were the only facilities in southwest Michigan that would accept the waste (and the nearest landfill that would accept TSCA waste was located in Detroit). Initially, just one landfill was identified for the non-TSCA waste, but during the first season of construction, that landfill temporarily stopped accepting waste. Removal activities were sometimes slowed and occasionally stopped while another landfill was identified and arrangements were made at the original facility to accommodate additional waste (ARCADIS 2009b).

The potential for restrictions in rate and capacity of waste disposal may significantly affect the timely completion of Alternative 3, given the large volume of material that would be disposed of offsite. If capacity at local solid waste facilities and TSCA landfills is exhausted, facilities outside of southwest Michigan would have to be considered, which would increase short-term risks since transport distances would be longer. Alternative 3 could be completed in 5 years assuming offsite disposal does not become a rate-limiting factor.

Substantial, contiguous areas of clean materials, such as the clean cap materials that cover portions of the landfill, will be beneficially reused onsite to the extent practicable. However, substantial, contiguous areas of uncontaminated paper residuals that could be segregated from the PCB-contaminated paper residuals are not anticipated to be identified. This assumption is based on the high variability of PCB concentrations within a limited area and the history of waste deposition. In situ waste characterization will be performed to determine the appropriate disposal facilities, but it is assumed that all paper residuals will require offsite disposal.

Excavation, offsite disposal, and restoration are implementable using readily available, conventional earth-moving equipment. The excavation of targeted offsite outlying areas is more complicated than the work proposed for the onsite areas, particularly given that parking lots will have to be removed to access soils in certain areas and buildings are in close proximity to the areas targeted for action. Excavations in the areas could extend as deep as 15 to 20 feet below the ground surface. Given this depth and the adjacent buildings, the excavations would need to be stabilized with temporary steel sheeting. Special implementation methods will also be required to drive the sheets while minimizing the potential for damage to the adjacent structure. For example, trenching and predrilling, and pile-driving using low vibratory methods may be required. In addition crack, vibration, and settlement monitoring will be required to identify any issues with adjacent property owners.

In addition, excavating to a depth of 15 to 20 feet below the ground surface significantly increases the likelihood of encountering groundwater—as a result, the same supplemental engineering controls described in the implementability section for Alternative 2 would be necessary in Alternative 3 to manage groundwater in the saturated fill. While the groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable.

The sheet pile removal element of this alternative would also be a relatively straightforward effort. The necessary support equipment (a crane to hold the steel while it is being readied for removal) is readily available. Offsite transport and disposal of the sheet pile is not anticipated since the steel should be able to be salvaged or sold. Since OU1 is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.4.7 Cost

Costs for Alternative 3 are associated with the following construction activities: project area preparation, excavation, offsite disposal, sheet pile removal, and restoration. The estimated cost associated with the implementation of Alternative 3 is presented in Table 5-9.

For Alternative 3, the total estimated capital cost of implementation is $188 million. The total estimated periodic cost for 5-year reviews is $120,000 in case any institutional controls are required. Since there is no O&M component, the total estimated 30-year present-worth cost associated with implementation of Alternative 3 is $189 million.

5.5 Alternative 4—Encapsulation Containment System

Alternative 4 includes the excavation of soil and/or sediment containing COCs above the relevant PRGs and disposal within a series of containment cells constructed onsite in the locations of the current Former Operational Areas.

Materials would be excavated from the Former Operational Areas; the Bryant HRDLs/FRDLs; the areas that lie close to Portage Creek, the targeted portions of Panelyte Marsh, Panelyte Property, and Conrail Property; the Outlying Areas (other than the portion of the Goodwill property covered by buildings); and the areas in the periphery of the Former Operational Areas near adjacent properties (Figure 4-4).

The areas would be excavated sequentially, with materials stockpiled during cell construction. Since the bottom of each disposal cell would need to be a minimum of 10 feet above the water table in order for the liner to function in a fully protective manner, clean fill would be added to raise the bottom of the cell to the appropriate elevation after excavation is complete. The base liner would then be constructed as described in Section 4.5, approximately 75 percent of the materials excavated from the Former Operational Areas would be placed in the cell, and the final cover system would be constructed. The remaining 25 percent of the excavated materials (which would be volumetrically displaced by the clean fill, the base liner, and the cover system) would be transported offsite for disposal along with the materials excavated from the Outlying Areas. The cell covers would be re-vegetated with native plants and grasses. Alternative 4 would also include long-term inspections and maintenance of the containment cells, monitoring of landfill gas and groundwater, and institutional controls.

5.5.1 Overall Protection of Human Health and the Environment

Alternative 4 would be an effective long-term remedy for OU1—it would eliminate the potential for direct contact with materials exceeding PRGs onsite and in the offsite outlying areas, eliminate the potential for human and ecological receptors to be exposed to materials containing COCs above the relevant PRGs, and eliminate the potential for contaminated materials to migrate into Portage Creek or onto offsite properties. This would be accomplished through excavation and onsite disposal in a series of containment cells, long-term monitoring and maintenance, and institutional controls. Since COCs would be left onsite, implementation of institutional controls and the monitoring and maintenance components of the remedy would be critical to maintaining protectiveness over time. This approach would achieve RAO 1 by mitigating the potential for human and ecological exposure to materials containing COCs above the relevant PRGs by isolation in the cells (and offsite disposal of materials displaced).

Implementation of Alternative 4 would also achieve RAO 2, since materials with COC concentrations above relevant PRGs left onsite would be encapsulated, thus eliminating the potential for migration to Portage Creek or onto adjacent properties. The complete liner system would mitigate any issues with the potential for contaminated material at OU1 from impacting groundwater or surface water and migrating to Portage Creek or offsite (RAO 3). The long-term groundwater monitoring program would be carried out to verify that groundwater conforms to the applicable risk-based standards. The long-term inspection and maintenance program for the newly constructed consolidation cells, along with the long-term landfill gas monitoring program, would further provide for protection of human health and the environment.

Overall protection of human health and the environment is expected to be achieved upon completion of the excavation/consolidation/disposal activities. It is anticipated that this remedy would take about 10 years to complete. Institutional controls would require maintenance of the disposal cells, which would provide for long-term protection of human health and environment.

5.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

- **Clean Water Act.** This Alternative will achieve this ARAR for the reasons set forth in Section 5.2.2.
- **Part 201, Environmental Remediation, of NREPA, 1994 PA 451, as amended (Part 201).** This Alternative will achieve this ARAR for the reasons set forth in Section 5.2.2.
- **Part 31, Water Resources Protection of NREPA, 1994, PA 451, as amended (Part 31).** This Alternative will achieve this ARAR for the reasons set forth in Section 5.2.2.
- **Part 55, Air Pollution Control, of NREPA (Part 55)** This Alternative will achieve this ARAR for the reasons set forth in Section 5.2.2.

- **Michigan Public Act 451, Part 303—Wetlands Protection.** This ARAR establishes rules regarding wetland uses. This Alternative is anticipated to comply with this ARAR. See discussion in Section 5.2.2.
- Part 91, Soil Erosion and Sedimentation Control of NREPA, 1994 PA 451, as amended (Part 91). This Alternative will require a plan similar to the one discussed in Section 5.2.2.
- **TSCA, 40 CFR § 761.61.** Alternative 4 meets the standards of 40 CFR § 761.50(b)(3)(i)(A) for remediation and will not pose an unreasonable risk of injury to health or the environment pursuant to 40 CFR § 761.61(c) because this Alternative will meet the PCB PRGs set forth in Table 2-3 for surface soils, subsurface soils, sediments and groundwater. The on-site disposal cell for this Alternative would meet a performance-based disposal method set forth in 40 CFR § 761.61(b)(2)(1) and by reference the substantive requirements of 40 CFR § 761.75. Offsite disposal of PCB materials will meet the performance-based disposal method set forth in 40 CFR § 761.61(b)(2)(1) and by reference the substantive requirements of 40 CFR § 761.75.
- **Michigan Public Act 451, Part 115 – Solid Waste Management.** This Alternative will exceed the cap requirements set forth in Part 115.

5.5.3 Long-term Effectiveness and Permanence

The primary components incorporated into Alternative 4—excavation, construction of a series of containment cells, consolidation, and offsite disposal—are proven and reliable. Alternative 4 would be expected to provide long-term protection of human health and the environment after the RAOs have been achieved. The disposal cells would be constructed with two impermeable engineered barriers—one above and one below the contained materials, which is a proven and effective method of isolating and eliminating potential contact with contaminated materials. The cells would mitigate the potential for COC-containing materials to migrate by air emissions, wind-blown particles, erosion or surface water runoff, into Portage Creek or onto adjacent properties.

Stability of OU1 and Outlying Areas would be improved as the entire property would be graded to a stable repose as part of the construction of the cells. Implementation of institutional controls and long-term monitoring and maintenance would provide for the long-term effectiveness and permanence of the disposal cells. The potential for failure of the impermeable barriers used to construct the cells is low, as O&M activities would effectively identify future maintenance needs. Future use of OU1 and potential long-term issues would be addressed through monitoring and institutional controls, including restrictive covenants, signage, and fencing. The details of long-term monitoring and maintenance would be developed during remedial design and compiled into an O&M program. Implementation of a long-term groundwater monitoring program would confirm that Alternative 4 achieves RAO 3, mitigating the potential for contaminated material to impact groundwater or surface water migrating to Portage Creek or offsite.

Alternative 4 also includes the removal of some or all of the existing sheet pile along the western bank of Portage Creek dependent upon the evaluation of landfill slope and bank stability in the design. The potential for groundwater mounding behind the wall will be included as part of the evaluation. The groundwater treatment system would be decommissioned and removed, and the network of groundwater extraction trenches, sumps, and wells currently in place behind the sheet pile wall would be removed and disposed. Alternative 4 would effectively reduce risks over the long term, and the monitoring components and institutional controls would provide mechanisms to verify the remedy is performing as anticipated over time.

Due to the larger footprint of the encapsulation system less area around the landfill would be available for redevelopment.

5.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 uses containment to reduce the mobility of COC-containing materials without treatment. Placement of contaminated materials within fully encapsulated containment cells reduces mobility of COCs and exposure potential by isolation. The toxicity of the material would not be changed.

5.5.5 Short-term Effectiveness

There are significant short-term risks associated with the implementation of Alternative 4. Because of the amount of work involved, these significant short-term risks would be issues for 10 years. Potential increases in COC exposure during site preparation and implementation (a result of either direct exposure or by dust-borne releases during excavation and handling of impacted materials), could be mitigated through the use of appropriate health and safety practices and by compliance with a health and safety plan. However, the mass of materials to be handled (1,600,000 yd^3) and the area of disturbance (a total of 65 acres) increase the chances of exposure. The number of work hours spent onsite around heavy equipment would be significant over a 10-year project, increasing the risk of an accident, as compared to an option for which fewer hours are spent in active construction.

Implementation of Alternative 4 would affect the community for many years. Due to the volume of material to be handled, excavation and cell construction are expected to take 10 years. There will be noise impacts, the potential for dust-borne releases, increased traffic, and significant wear and tear on local roads during implementation. Excavation work is not confined to the warmer months, so excavation work would be carried out year-round, 5 days per week. Cell construction would be restricted to the Michigan construction season, which is typically late March or early April through the end of October, depending on weather.

Over the course of the project, more than 116,000 truck trips would be necessary to transport excavated material from the offsite outlying areas to the onsite disposal cells, to bring in clean fill, and to haul displaced materials to offsite disposal locations. During the approximately 5 years of the project when excavation and filling work would be the focus, there would be an average of 90 trucks per day in and out of OU1. There would be short-term environmental impacts associated with the potential for offsite migration due to dust-borne releases or incidental releases to Portage Creek given that 65 acres will be disturbed during the implementation of Alternative 4. The dust-borne releases could be readily mitigated by keeping the excavation/consolidation areas/materials appropriately wet, but the size of the area being disturbed increases the risk nonetheless.

Reasonable and appropriate controls (for example, silt curtains) would be implemented when removing materials that lie close to Portage Creek and wetland areas of OU1 to mitigate impacts to the environments. The removal of materials beneath the Alcott Street and Goodwill parking lots would cause short-term impacts to neighboring properties/property owners. The excavations at these locations may reach 15 to 20 feet or more below grade, and are expected to require benching and/or sheet pile to allow removal to target depths. The installation and removal of sheet pile will create noise and cause vibrations in the immediate area during the period of construction, potentially disturbing nearby property owners/occupants.

Areas disturbed during implementation would be restored after construction with appropriate native plantings (or restored as wetland areas, if appropriate), and the habitat in the impacted areas would be expected to recover quickly.

5.5.6 Implementability

All the major components of Alternative 4 are proven, readily implementable, and expected to be reliable over long time scales. Administratively, this approach is implementable, and could be completed in 10 years, assuming offsite disposal does not become a rate-limiting factor.

From a technical perspective, Alternative 4 is implementable using readily available, conventional earth-moving equipment. The necessary services and construction materials are expected to be readily available, and qualified commercial contractors with experience at other Kalamazoo River Superfund Site OUs are available locally to perform the work.

The sheet pile removal element of this alternative would also be a relatively straightforward effort. The necessary support equipment (a crane to hold the steel while it is being cut) is readily available. Offsite transport and disposal of the sheet pile is not anticipated since the steel should be able to be salvaged or sold.

The key issues with Alternative 4 are related to sequencing, space constraints, and landfill capacity. Given the quantity of materials targeted for excavation and disposal in the containment cells, the project would have to be carried out in phases. In each phase of the onsite work, soils from a particular area would have to be removed, temporarily staged to allow for construction of the base liner, and replaced in the cell. Then the cover system would be installed, and the crew would move on to the next area. The logistical issues associated with implementation of Alternative 4 could likely be complicated, and the complexity of the operation would increase as the project progresses. Soils would be excavated from one area, and temporarily staged in another while clean fill is brought in to establish the base elevation and the base liner is constructed. The need to add approximately 10 feet of clean fill to raise the bottom liner 4 feet above the water table will limit the amount of space available for disposal.

Approximately 75 percent of the soils from the Former Operational Areas would be placed/graded/compacted in the cell and the final cover would be constructed. The remaining 25 percent of the soils targeted for excavation and the soils excavated from the offsite outlying areas would be volumetrically displaced, which means that more than 500,000 yd^3 of materials would have to be transported offsite for disposal. As described in the implementability discussion for Alternative 3, the number of landfills available in southwest Michigan able to take large quantities of materials is limited. Even if appropriate disposal facilities are identified, the landfill capacity and other needs/restrictions (such as, no PCB-containing materials placed at the bottom of a disposal cell or near the leachate collection/drainage system) could limit the rate at which materials could be hauled offsite. If sufficient capacity in southwest Michigan is not available, facilities across a larger area would have to be considered, which would increase short-term risks since transport distances would be longer. Collectively, the factors could potentially increase the implementation timeframe.

Substantial, contiguous areas of clean materials, such as the clean cap materials that cover portions of the landfill, will be beneficially reused onsite to the extent practicable. However, substantial, contiguous areas of uncontaminated paper residuals that could be segregated from the PCB-contaminated paper residuals are not anticipated to be identified. This assumption is based on the high variability of PCB concentrations within a limited area and the history of waste deposition. In situ waste characterization will be performed to determine the appropriate disposal, but it is assumed that all paper residuals will require encapsulation within the containment cell or offsite disposal.

Similar implementability issues as described in earlier alternatives would be encountered in the targeted offsite outlying areas located underneath existing parking lots. The excavations would need to be stabilized with temporary steel sheeting, and special implementation methods would be required to drive the sheets while minimizing the potential for damage to the adjacent structure. In addition, the same supplemental engineering controls described in the implementability section for Alternative 3 would be necessary in Alternative 4 to manage groundwater in the saturated fill. While the groundwater management measures will present additional design and construction challenges, they are technically feasible and implementable. Since OU1 is part of a CERCLA site, permits are not required for onsite activities; however, the substantive applicable requirements of federal and state regulations would need to be met.

5.5.7 Cost

Costs for Alternative 4 are associated with the following construction activities: project area preparation, excavation, installation/construction of the containment cells, offsite disposal, sheet pile removal, restoration, and monitoring. The estimated costs associated with the implementation of Alternative 4 are presented in Table 5-10.

For Alternative 4, the total estimated capital cost of implementation is $131 million, and the total estimated O&M cost is $5.5 million. The total estimated periodic cost for 5-year reviews is $120,000. The total estimated 30-year present-worth cost associated with implementation of Alternative 4 is $136 million.

TABLE 5-1

Cost Estimate for Remedial Alternative 1

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
				TOTAL CAPITAL COST:	**$0**
II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
				TOTAL O&M COST:	**$0**
III. PERIODIC COSTS				**Discount Rate**	**1.1%**
5-Year Reviews		**Annual Cost**		**Discount Factor**	**Net Present Value**
1	Year 5	$25,000	YR	0.95	$23,669
2	Year 10	$25,000	YR	0.90	$22,409
3	Year 15	$25,000	YR	0.85	$21,216
4	Year 20	$25,000	YR	0.80	$20,087
5	Year 25	$25,000	YR	0.76	$19,018
6	Year 30	$25,000	YR	0.72	$18,006
				TOTAL PERIODIC COST:	**$124,405**
				TOTAL ESTIMATED COST:	**$124,405**
				ROUNDED TO:	**$124,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK= Week; MO = Month.

Item Notes (where applicable):

1 - 7 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-2

Cost Estimate for Remedial Alternative 2A

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1	Pre-construction Field Survey	1	LS	$5,000	$5,000
2	Air Monitoring Program	280	DAY	$1,500	**$420,000**
3	Temporary Fencing	1	LS	$15,000	$15,000
4	Decontamination Area	1	EA	$35,000	$35,000
5	Temporary Construction Access Roads	1	LS	$80,000	$80,000
6	Clearing & Grubbing	20	AC	$12,000	$240,000
7	Temporary Steel Sheeting (Drive, Extract and Salvage: Means 31 41 16.10 0100)	0	TON	$2,100	$0
8	Utility Protection / Relocation	1	LS	$100,000	$100,000
9	Temporary Stormwater Management and Erosion and Sediment	1	LS	$250,000	$250,000
10	Well Abandonment	18	EA	$600	$10,800
				Site Preparation Subtotal:	**$1,155,800**
Excavation and Consolidation					
11	Survey	10	WK	$5,000	$50,000
12	Soil Removal and Consolidation	320000	CY	$13	$4,000,000
12a	Construction Water Treatment System	280	days	$10,000	$2,800,000
13	Confirmation Sampling	300	EA	$500	$150,000
14	Remove Sheet Pile Wall	2600	LF	$110	$286,000
15a	Soil Removal and Consolidation (setback from creek)	19000	CY	$13	$237,500
15b	Soil Removal and Consolidation (setback from creek)	11000	CY	$13	$137,500
				Excavation and Consolidation Subtotal:	**$7,661,000**
Final Cover System					
16	Grade Verification Surveys	8	WK	$5,000	$40,000
17	Soil Grading Layer (Select Fill)	39,000	CY	$20	$780,000
18	Geotextile Separation Layer (8-oz/sy)	278,000	SY	$2.50	$695,000
19	Gas Venting Layer (Sand)	78,000	CY	$20.00	$1,560,000
20	Passive Gas Vents	40	EA	$1,000.00	$40,000
21	30-mil PVC Liner (or equivalent)	278,000	SY	$7.50	$2,085,000
22	Geotextile Cushion Layer (16-oz/sy)	278,000	SY	$4.50	$1,251,000
23	Soil Protection / Drainage Layer (Sand)	156,000	CY	$20.00	$3,120,000
24	Topsoil Layer	39,000	CY	$30.00	$1,170,000
25	Seed & Mulch	48	AC	$2,100.00	$100,380
				Final Cover System:	**$10,841,380**
Permanent Stormwater Management					
28	Vegetated Swales	9,500	LF	$15	$142,500
29	Riprap-lined Swales	4,000	LF	$100	$400,000
30	Riprap Slope Protection	1	LS	$400,000	$400,000
31	Culverts	1,000	LF	$30	$30,000
32	Subsurface Drain Piping	4,000	LF	$45	$180,000
33	Stormwater Basins	3	EA	$80,000	$240,000
				Permanent Stormwater Management Subtotal:	**$1,392,500**
Restoration					
34	As-built Survey	6	WK	$5,000	$30,000
35	Backfill	170,000	CY	$20	$3,400,000
36	Topsoil	14,000	CY	$30	$420,000
37	Seed & Mulch	17	AC	$2,100	$35,700
38	Permanent Gravel Access Roads	1	LS	$250,000	$250,000
				Restoration Subtotal:	**$4,135,700**
Post-closure Monitoring Features Installation					
39	Installation of Permanent Gas Monitoring Probes	8	EA	$5,000	$40,000
40	Installation of Perimeter Gas Venting Trenches	19,250	SF	$30	$577,500
41	Installation of Post-closure Groundwater Monitoring Well Network	24	EA	$6,000	$144,000
				Post-closure Monitoring Features Installation Subtotal:	**$761,500**

TABLE 5-2

Cost Estimate for Remedial Alternative 2A

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
				CAPITAL COST SUBTOTAL:	**$25,947,880**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$518,958**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$1,297,394**
				Administration, Design, and Construction Oversight:	**$1,500,000**
				Independent Construction Quality Assurance (10% of Final Cover System Capital Costs):	**$1,084,138**
				Contingency (20% of Subtotal Capital Cost):	**$5,189,576**
				TOTAL CAPITAL COST:	**$35,537,946**

II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Post-closure Inspections & Maintenance		**Annual Cost**		**Discount Factor**	**Net Present Value**
42	Years 1-5	$150,000	YR	4.84	$725,872
43	Years 6-30	$75,000	YR	20.60	$1,544,653
				Post-closure Inspections & Maintenance Subtotal:	**$2,270,525**
Post-closure Landfill Gas Monitoring & Reporting					
44	Years 1-5	$6,000	YR	4.84	$29,035
45	Years 6-30	$3,000	YR	20.60	$61,786
				Post-closure Landfill Gas Monitoring & Reporting Subtotal:	**$90,821**
Post-closure Groundwater Sampling & Reporting					
46	Years 1-5	$250,000	YR	4.84	$1,209,786
47	Years 6-30	$125,000	YR	20.60	$2,574,422
				Post-closure Groundwater Sampling & Reporting Subtotal:	**$3,784,208**
				O&M COST SUBTOTAL:	**$6,145,554**
				Contingency (20% of Subtotal O&M Cost):	**$1,229,111**
				TOTAL O&M COST:	**$7,374,665**

III. PERIODIC COSTS				**Discount Rate**	**1.1%**
5-Year Reviews		**Annual Cost**		**Discount Factor**	**Net Present Value**
48	Year 5	$25,000	YR	0.95	$23,669
49	Year 10	$25,000	YR	0.90	$22,409
50	Year 15	$25,000	YR	0.85	$21,216
51	Year 20	$25,000	YR	0.80	$20,087
52	Year 25	$25,000	YR	0.76	$19,018
53	Year 30	$25,000	YR	0.72	$18,006
				TOTAL PERIODIC COST:	**$124,405**
				TOTAL ESTIMATED COST:	**$43,037,016**
				ROUNDED TO:	**$43,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the projected cost.

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during COC-containing material handling only (e.g., excavation, consolidation, subgrade preparation).

TABLE 5-2

Cost Estimate for Remedial Alternative 2A

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost

6. Clearing and grubbing unit cost is based on cutting and chipping of medium to heavily forested area and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot-long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL.

12 Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of COC-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), approximately 35,000 cubic yards of material along the peripheral area of the Monarch HRDL, and approximately 99,500 cubic yards of material from outlying areas.

13 Confirmation sample quantity assumes that all soil removal areas will be sampled on a 50 foot by 50 foot grid to confirm removal of COC-containing material.

14 Estimated quantity and cost is not based on calculation, rather it is an estimate based on site topography and the potential for sheet pile removal based on slope stability considerations. Lineal footage and costs to be determined during design phase.

15a Estimated quantity is based on a setback 30' wide along a linear distance of 2,100 feet along Bryant HRDL/FRDLs and Portage Creek. Estimated excavation depth is 8 feet, based on nearby borings.

15b Estimated quantity is based on a setback 30' wide along a linear distance of 1,200 feet along Monarch HRDL and Portage Creek. Estimated excavation depth is an average of 8 feet based on nearby borings.

16 - 25 Final cover quantities are based on the following estimated areas: Former Type III Landfill - 10 acres, Western Disposal Area - 12 acres, Bryant HRDLs/FRDLs - 20.7 acres, and Monarch HRDL - 5.2 acres.

17 Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire consolidation/cover system areas and is the first layer of the cover system.

18 Geotextile separation layer cost estimate assumes using a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer.

23 Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area.

24 Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas.

25 Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system.

26 Slurry wall costs include all components of design and construction. Groundwater collection and treatment not costed here as the slurry wall cost will be

28 Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only.

29 Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only.

31 Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only.

32 It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping.

33 Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration.

34 - 38 Restoration quantity assumes approximately 17 acres of soil removal area, located outside the limits of capping, as specified in the following: Former Type III Landfill - 3.6 acres, Western Disposal Area - 3.6 acres, Bryant HRDL/RDL - 1.4 acres, Monarch HRDL - 1.6 acres, commercial properties - 5.3 acres and Residential/MHLLC-Owned properties including Golden Age) - 1.5 acres.

35 Estimated backfill quantities are based on the volume of clean fill material that will be required to backfill the peripheral soil removal areas located outside the limits of capping to appropriate subgrade elevation.

36 Topsoil quantity is based on covering approximately 17 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil.

37 Seed and mulch quantity is based on covering the 17 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth.

38 Permanent access road quantity based on an assumed 8,000 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes.

42 - 47 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-3

Cost Estimate for Remedial Alternative 2B

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1	Pre-construction Field Survey	1	LS	$5,000	$5,000
2	Air Monitoring Program	280	DAY	$1,500	**$420,000**
3	Temporary Fencing	1	LS	$15,000	$15,000
4	Decontamination Area	1	EA	$35,000	$35,000
5	Temporary Construction Access Roads	1	LS	$80,000	$80,000
6	Clearing & Grubbing	20	AC	$12,000	$240,000
7	Temporary Steel Sheeting (Drive, Extract and Salvage: Means 31 41 16.10 0100)	282	TON	$2,100	$592,200
8	Utility Protection / Relocation	1	LS	$100,000	$100,000
9	Temporary Stormwater Management and Erosion and Sediment	1	LS	$250,000	$250,000
10	Well Abandonment	18	EA	$600	$10,800
				Site Preparation Subtotal:	**$1,748,000**
Excavation and Consolidation					
11	Survey	10	WK	$5,000	$50,000
12	Soil Removal and Consolidation	460000	CY	$12.5	$5,750,000
12a	Construction Water Treatment System	200	days	$10,000	$2,000,000
13	Confirmation Sampling	390	EA	$500	$195,000
14	Remove Sheet Pile Wall	2600	LF	$110	$286,000
15	Soil Removal and Consolidation (setback from creek)	19000	CY	$12.5	$237,500
				Excavation and Consolidation Subtotal:	**$8,518,500**
Final Cover System					
16	Grade Verification Surveys	8	WK	$5,000	$40,000
17	Soil Grading Layer (Select Fill)	34,000	CY	$20	$680,000
18	Geotextile Separation Layer (8-oz/sy)	248,000	SY	$2.50	$620,000
19	Gas Venting Layer (Sand)	68,000	CY	$20	$1,360,000
20	Passive Gas Vents	30	EA	$1,000	$30,000
21	30-mil PVC Liner (or equivalent)	248,000	SY	$7.50	$1,860,000
22	Geotextile Cushion Layer (16-oz/sy)	248,000	SY	$4.50	$1,116,000
23	Soil Protection / Drainage Layer (Sand)	136,000	CY	$20	$2,720,000
24	Topsoil Layer	34,000	CY	$30	$1,020,000
25	Seed & Mulch	43	AC	$2,100	$89,670
				Final Cover System Subtotal:	**$9,535,670**
Permanent Stormwater Management					
28	Vegetated Swales	8,000	LF	$15	$120,000
29	Riprap-lined Swales	3,000	LF	$100	$300,000
30	Riprap Slope Protection	1	LS	$300,000	$300,000
31	Culverts	800	LF	$30	$24,000
32	Subsurface Drain Piping	4,000	LF	$45	$180,000
33	Stormwater Basins	2	EA	$80,000	$160,000
				Permanent Stormwater Management Subtotal:	**$1,084,000**
Restoration					
34	As-built Survey	6	WK	$5,000	$30,000
35	Backfill	185,000	CY	$20	$3,700,000
36	Topsoil	18,000	CY	$30	$540,000
37	Seed & Mulch	22.2	AC	$2,100	$46,620
38	Permanent Gravel Access Roads	1	LS	$250,000	$250,000
				Restoration Subtotal:	**$4,566,620**
Post-closure Monitoring Features Installation					
39	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
40	Installation of Perimeter Gas Venting Trenches	14,500	SF	$30	$435,000
41	Installation of Post-closure Groundwater Monitoring Well Network	20	EA	$6,000	$120,000
				Post-closure Monitoring Features Installation Subtotal:	**$585,000**
				CAPITAL COST SUBTOTAL:	**$26,037,790**

TABLE 5-3

Cost Estimate for Remedial Alternative 2B

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
		Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):			**$520,756**
		Mobilization/Demobilization (5% of Subtotal Capital Cost):			**$1,301,890**
		Administration, Design, and Construction Oversight:			**$1,500,000**
		Independent Construction Quality Assurance (10% of Final Cover System Capital Costs):			**$953,567**
		Contingency (20% of Subtotal Capital Cost):			**$5,207,558**
		TOTAL CAPITAL COST:			**$35,521,560**
II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Post-closure Inspections & Maintenance		**Current Annual Cost**		**NPV Factor**	**NPV**
42	Years 1-5	$100,000	YR	4.84	$483,914
43	Years 6-30	$50,000	YR	20.60	$1,029,769
		Post-closure Inspections & Maintenance Subtotal:			**$1,513,683**
Post-closure Landfill Gas Monitoring & Reporting					
44	Years 1-5	$4,000	YR	4.84	$19,357
45	Years 6-30	$2,000	YR	20.60	$41,191
		Post-closure Landfill Gas Monitoring & Reporting Subtotal:			**$60,547**
Post-closure Groundwater Sampling & Reporting					
46	Years 1-5	$200,000	YR	4.84	$967,829
47	Years 6-30	$100,000	YR	20.60	$2,059,538
		Post-closure Groundwater Sampling & Reporting Subtotal:			**$3,027,367**
		O&M COST SUBTOTAL:			**$4,601,597**
		Contingency (20% of Subtotal O&M Cost):			**$920,319**
		TOTAL O&M COST:			**$5,521,917**
III. PERIODIC COSTS				**Discount Rate**	**1.1%**
5-Year Reviews		**Annual Cost**		**Discount Factor**	**Net Present Value**
48	Year 5	$25,000	YR	0.95	$23,669
49	Year 10	$25,000	YR	0.90	$22,409
50	Year 15	$25,000	YR	0.85	$21,216
51	Year 20	$25,000	YR	0.80	$20,087
52	Year 25	$25,000	YR	0.76	$19,018
53	Year 30	$25,000	YR	0.72	$18,006
		TOTAL PERIODIC COST:			**$124,405**
		TOTAL ESTIMATED COST:			**$41,167,882**
		ROUNDED TO:			**$41,000,000**

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the projected cost.

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc., that is with winter shutdown.

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during COC-containing material handling only (e.g., excavation, consolidation, subgrade preparation).

6. Clearing and grubbing unit cost is based on cutting and chipping of medium to heavily forested area and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL.

TABLE 5-3

Cost Estimate for Remedial Alternative 2B

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
12	Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of COC-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 190,000 cubic yards of material along the peripheral areas of the Former Type III Landfill and the Western Disposal Area (including the Panelyte Property, Panelyte Marsh, and Conrail Property), approximately 170,000 cubic yards from the Monarch HRDL, and approximately 99,500 cubic yards of material from outlying areas.				
13	Confirmation sample quantity assumes that all soil removal areas will be sampled on a 50-foot by 50-foot grid to confirm removal of COC-containing material.				
14	Estimated quantity and cost is not based on calculation, rather it is an estimate based on site topography and the potential for sheet pile removal based on slope stability considerations. Lineal footage and costs to be determined during design phase.				
15	Estimated quantity is based on a setback 30-foot-wide along a linear distance of 2,100 feet along Bryant HRDL/FRDLs and Portage Creek. Estimated excavation depth is 8 feet based on nearby borings.				
16 - 25	Final cover quantities are based on the following estimated areas: Former Type III Landfill - 10 acres, Western Disposal Area - 12 acres, and Bryant HRDLs/FRDLs - 20.7 acres.				
17	Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire consolidation/cover system areas and is the first layer of the earthen cover system.				
18	Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer.				
23	Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area.				
24	Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas.				
25	Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system.				
26	Slurry wall costs include all components of design and construction. Groundwater collection and treatment (Contingency 2) not costed here as the slurry wall cost will be higher.				
28	Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only.				
29	Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only.				
31	Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only.				
32	It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping.				
33	Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration.				
34 - 38	Restoration quantity assumes approximately 22 acres of soil removal area, located outside the limits of capping, as specified in the following: Former Type III Landfill - 3.6 acres, Western Disposal Area - 3.6 acres, Bryant HRDL/RDL - 1.4 acres, Monarch HRDL - 6.8 acres, commercial properties - 5.3 acres and Residential/MHLLC-Owned properties including Golden Age) - 1.5 acres.				
35	Estimated backfill quantities are based on the volume of clean fill material that will be required to backfill the peripheral soil removal areas located outside the limits of capping to appropriate subgrade elevation. An estimated 50,000 cubic yards will be used to backfill the Monarch HRDL. Actual quantities will be determined during the design.				
36	Topsoil quantity is based on covering approximately 22 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil.				
37	Seed and mulch quantity is based on covering the 22 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth.				
38	Permanent access road quantity based on an assumed 8,000 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes.				
42 - 47	Net present value (NPV) factors calculated using the following equation:				

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-4

Cost Estimate for Remedial Alternative 2C

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1	Pre-construction Field Survey	1	LS	$5,000	$5,000
2	Air Monitoring Program	280	DAY	$1,500	**$420,000**
3	Temporary Fencing	1	LS	$15,000	$15,000
4	Decontamination Area	1	EA	$35,000	$35,000
5	Temporary Construction Access Roads	1	LS	$80,000	$80,000
6	Clearing & Grubbing	20	AC	$12,000	$240,000
7	Temporary Steel Sheeting (Drive, Extract and Salvage: Means 31 41 16.10 0100)	282	TON	$2,100	$592,200
8	Utility Protection / Relocation	1	LS	$100,000	$100,000
9	Temporary Stormwater Management and Erosion and Sediment	1	LS	$250,000	$250,000
10	Well Abandonment	18	EA	$600	$10,800
			Site Preparation Subtotal:		**$1,748,000**
Excavation and Consolidation					
11	Survey	10	WK	$5,000	$50,000
12	Soil Removal and Consolidation	445,000	CY	$12.5	$5,562,500
12a	Construction Water Treatment System	200	days	$10,000	$2,000,000
13	Confirmation Sampling	390	EA	$500	$195,000
14	Remove Sheet Pile Wall	2,600	LF	$110	$286,000
14a	Soil Removal and Consolidation (setback from creek)	19,000	CY	$12.5	$237,500
			Excavation and Consolidation Subtotal:		**$8,331,000**
Excavation, Transportation, and Incineration of > 500 mg/kg material					
15	Additional Hot Spot Investigation	1	LS	$50,000	$50,000
15a	Excavation	15,000	CY	$12.5	$187,500
15b	Transportation & Disposal	24,250	tons	$690	$16,732,500
			Excavation, Transportation, and Incineration Subtotal:		**$16,970,000**
Final Cover System					
16	Grade Verification Surveys	8	WK	$5,000	$40,000
17	Soil Grading Layer (Select Fill)	34,000	CY	$20	$680,000
18	Geotextile Separation Layer (8-oz/sy)	248,000	SY	$2.50	$620,000
19	Gas Venting Layer (Sand)	68,000	CY	$20	$1,360,000
20	Passive Gas Vents	30	EA	$1,000	$30,000
21	30-mil PVC Liner (or equivalent)	248,000	SY	$7.50	$1,860,000
22	Geotextile Cushion Layer (16-oz/sy)	248,000	SY	$4.50	$1,116,000
23	Soil Protection / Drainage Layer (Sand)	136,000	CY	$20	$2,720,000
24	Topsoil Layer	34,000	CY	$30	$1,020,000
25	Seed & Mulch	43	AC	$2,100	$89,670
			Final Cover System Subtotal:		**$9,535,670**
Permanent Stormwater Management					
28	Vegetated Swales	8,000	LF	$15	$120,000
29	Riprap-lined Swales	3,000	LF	$100	$300,000
30	Riprap Slope Protection	1	LS	$300,000	$300,000
31	Culverts	800	LF	$30	$24,000
32	Subsurface Drain Piping	4,000	LF	$45	$180,000
33	Stormwater Basins	2	EA	$80,000	$160,000
			Permanent Stormwater Management Subtotal:		**$1,084,000**
Restoration					
34	As-built Survey	6	WK	$5,000	$30,000
35	Backfill	185,000	CY	$20	$3,700,000
36	Topsoil	18,000	CY	$30	$540,000
37	Seed & Mulch	22.2	AC	$2,100	$46,620
38	Permanent Gravel Access Roads	1	LS	$250,000	$250,000
			Restoration Subtotal:		**$4,566,620**
Post-closure Monitoring Features Installation					
39	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000

TABLE 5-4

Cost Estimate for Remedial Alternative 2C

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
40	Installation of Perimeter Gas Venting Trenches	14,500	LF	$30	$435,000
41	Installation of Post-closure Groundwater Monitoring Well Network	20	EA	$6,000	$120,000
				Post-closure Monitoring Features Installation Subtotal:	**$585,000**
				CAPITAL COST SUBTOTAL:	**$42,820,290**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$856,406**
				Mobilization/Demobilization:	**$1,500,000**
				Administration, Design, and Construction Oversight:	**$2,000,000**
				Independent Construction Quality Assurance (10% of Final Cover System Capital Costs):	**$953,567**
				Contingency (20% of Subtotal Capital Cost):	**$8,564,058**
				TOTAL CAPITAL COST:	**$56,694,321**

II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Post-closure Inspections & Maintenance		**Current Annual Cost**		**NPV Factor**	**NPV**
42	Years 1-5	$100,000	YR	4.84	$483,914
43	Years 6-30	$50,000	YR	20.60	$1,029,769
				Post-closure Inspections & Maintenance Subtotal:	**$1,513,683**
Post-closure Landfill Gas Monitoring & Reporting					
44	Years 1-5	$4,000	YR	4.84	$19,357
45	Years 6-30	$2,000	YR	20.60	$41,191
				Post-closure Landfill Gas Monitoring & Reporting Subtotal:	**$60,547**
Post-closure Groundwater Sampling & Reporting					
46	Years 1-5	$200,000	YR	4.84	$967,829
47	Years 6-30	$100,000	YR	20.60	$2,059,538
				Post-closure Groundwater Sampling & Reporting Subtotal:	**$3,027,367**
				O&M COST SUBTOTAL:	**$4,601,597**
				Contingency (20% of Subtotal O&M Cost):	**$920,319**
				TOTAL O&M COST:	**$5,521,917**

III. PERIODIC COSTS				**Discount Rate**	**1.1%**
5-Year Reviews		**Annual Cost**		**Discount Factor**	**Net Present Value**
48	Year 5	$25,000	YR	0.95	$23,669
49	Year 10	$25,000	YR	0.90	$22,409
50	Year 15	$25,000	YR	0.85	$21,216
51	Year 20	$25,000	YR	0.80	$20,087
52	Year 25	$25,000	YR	0.76	$19,018
53	Year 30	$25,000	YR	0.72	$18,006
				TOTAL PERIODIC COST:	**$124,405**
				TOTAL ESTIMATED COST:	**$62,340,643**
				ROUNDED TO:	**$62,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the projected cost.

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

TABLE 5-4

Cost Estimate for Remedial Alternative 2C

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost

Item Notes (where applicable):

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during COC-containing material handling only (e.g., excavation, consolidation, subgrade preparation).

6. Clearing and grubbing unit cost is based on cutting and chipping of medium to heavily forested area and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL.

12 Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of COC-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas.

13 Confirmation sample quantity assumes that all soil removal areas will be sampled on a 50 foot by 50 foot grid to confirm removal of COC-containing material.

14 Estimated quantity and cost is not based on calculation, rather it is an estimate based on site topography and the potential for sheet pile removal based on slope stability considerations. Lineal footage and costs to be determined during design phase.

14a Estimated quantity is based on a setback 30' wide along a linear distance of 2100 feet along Bryant HRDL/FRDLs and Portage Creek. Estimated excavation depth is 8 feet based on nearby borings.

15 Estimated quantity of material above > 500 mg/kg taken from percentages presented in FIELDS analysis. Transportation and Disposal cost based on previous quotes from facilities that can handle this material. Added $25/ton to account for staging/stockpile maintenance due to limited amount of material that can be processed at incinerator.

16 - 25 Final cover quantities are based on the following estimated areas: Former Type III Landfill - 10 acres, Western Disposal Area - 12 acres, and Bryant HRDLs/FRDLs - 20.7 acres.

17 Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire consolidation/cover system areas and is the first layer of the earthen cover system.

18 Geotextile separation layer cost estimate assumes using a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer.

23 Soil protection/drainage layer consists of a 2-foot-thick layer of sand covering the entire cover system area.

24 Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas.

25 Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system.

26 Slurry wall costs include all components of design and construction. Groundwater collection and treatment (Contingency 2) not costed here as the slurry wall cost will be higher.

28 Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only.

29 Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only.

31 Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only.

32 It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping.

33 Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration.

34 - 38 Restoration quantity assumes approximately 22 acres of soil removal area, located outside the limits of capping, as specified in the following: Former Type III Landfill - 3.6 acres, Western Disposal Area - 3.6 acres, Bryant HRDL/RDL - 1.4 acres, Monarch HRDL - 6.8 acres, commercial properties - 5.3 acres and Residential/MHLLC-Owned properties including Golden Age) - 1.5 acres.

35 Estimated backfill quantities are based on the volume of clean fill material that will be required to backfill the peripheral soil removal areas located outside the limits of capping to appropriate subgrade elevation. An estimated 50,000 cubic yards will be used to backfill the Monarch HRDL. Actual quantities will be determined during the design.

36 Topsoil quantity is based on covering approximately 22 acres of soil removal area, located outside the limits of capping, with 6 inches of topsoil.

37 Seed and mulch quantity is based on covering the 22 acres of topsoil placed over the outlying soil removal areas, as necessary to promote vegetative growth.

38 Permanent access road quantity based on an assumed 8,000 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes.

42 - 47 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-5

Cost Estimate for Remedial Alternative 2A Groundwater Subalternative (i)

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Groundwater Collection Trench					
1	Pre-construction Field Survey	1	LS	$25,000	**$25,000**
2	Work Planning	1	LS	$150,000	$150,000
3	Design	1	LS	$60,000	$60,000
4	GW Collection Trench & Backfill	67,500	SF	$5.5	$371,250
5	Spoils Consolidated in Landfill	12,500	CY	$5.0	$62,500
6	GW Transfer Piping and Appurtenances	1	LS	$400,000	$400,000
7	GW System Start Up	1	LS	$75,000	$75,000
				Post-closure Monitoring Features Installation Subtotal:	**$1,143,750**
				CAPITAL COST SUBTOTAL:	**$1,143,750**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$22,875**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$57,188**
				Administration and Construction Oversight(10% of Subtotal Capital Cost):	**$114,375**
				Contingency (20% of Subtotal Capital Cost):	**$228,750**
				TOTAL CAPITAL COST:	**$1,566,938**
II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Groundwater Treatment		**Current Annual Cost**		**NPV Factor**	**NPV**
8	Years 1-5	$100,000	YR	4.84	$483,914
9	Years 6-30	$100,000	YR	20.60	$2,059,538
				Groundwater Treatment	**$2,543,452**
				O&M COST SUBTOTAL:	**$2,543,452**
				Contingency (20% of Subtotal O&M Cost):	**$508,690**
				TOTAL O&M COST:	**$3,052,143**
				TOTAL ESTIMATED COST:	**$4,619,080**
				ROUNDED TO:	**$5,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the projected cost.

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SF = Square Foot; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

3 Design includes evaluation of current O&M system and components for use with the proposed system. For this alternative, design costs are specifically included in the cost instead of as a percentage of the construction costs.

4 Groundwater collection trench costs based on similar project experience; square footage based on an approximate estimate.

5 Piping, lift stations, and extraction well costs based on similar project costs.

6 System start up costs based on ten days of prove-out; based on previous project experience.

8 - 9 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-6

Cost Estimate for Remedial Alternative 2A Groundwater Subalternative (ii)

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
	Slurry Wall and Hydraulic Control				
I. CAPITAL COSTS					
Groundwater Collection Trench					
1	Pre-construction Field Survey	1	LS	$25,000	**$25,000**
2	Work Planning	1	LS	$150,000	$150,000
3	Design	1	LS	$60,000	$60,000
4	GW Collection Trench & Backfill	67,500	SF	$5.5	$371,250
5	Spoils Consolidated in Landfill	12,500	CY	$5.0	$62,500
6	GW Transfer Piping and Appurtenances	1	LS	$400,000	$400,000
7	GW System Start Up	1	LS	$75,000	$75,000
	Post-closure Monitoring Features Installation Subtotal:				**$1,143,750**
Slurry Wall					
8	Installation of Slurry Wall	270,000	SF	$16.40	$4,428,000
9	Spoils Consolidated in Landfill	400,000	CY	$5.00	$2,000,000
	Slurry Wall Subtotal				**$6,428,000**
	CAPITAL COST SUBTOTAL:				**$7,571,750**
	Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):				**$151,435**
	Mobilization/Demobilization (5% of Subtotal Capital Cost):				**$378,588**
	Administration and Construction Oversight(10% of Subtotal Capital Cost):				**$757,175**
	Contingency (20% of Subtotal Capital Cost):				**$1,514,350**
	TOTAL CAPITAL COST:				**$10,373,298**

Item No.	Description	Current Annual Cost		NPV Factor	NPV
II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Groundwater Treatment		**Current Annual Cost**		**NPV Factor**	**NPV**
9	Years 1-5	$100,000	YR	4.84	$483,914
10	Years 6-30	$100,000	YR	20.60	$2,059,538
	Groundwater Treatment				**$2,543,452**
	O&M COST SUBTOTAL:				**$2,543,452**
	Contingency (20% of Subtotal O&M Cost):				**$508,690**
	TOTAL O&M COST:				**$3,052,143**
	TOTAL ESTIMATED COST:				**$13,425,440**
	ROUNDED TO:				**$13,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

3 Design includes evaluation of current O&M system and components for use with the proposed system. For this alternative, design costs are specifically

4 Groundwater collection trench costs based on similar project experience; square footage based on an approximate estimate.

5 Piping, lift stations, and extraction well costs based on similar project costs.

6 System start up costs based on ten days of prove-out; based on previous project experience.

7 Slurry wall costs presented on a square foot basis; include design, site restoration, and other ancillary activities. Costs based on project experience.

8 - 9 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-7

Cost Estimate for Remedial Alternatives 2B & 2C Groundwater Subalternative (i)

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
	Groundwater Collection and Treatment				
I. CAPITAL COSTS					
Groundwater Collection Trench					
1	Pre-construction Field Survey	1	LS	$25,000	**$25,000**
2	Work Planning	1	LS	$150,000	$150,000
3	Design	1	LS	$60,000	$60,000
4	GW Collection Trench & Backfill	55,000	SF	$5.5	$302,500
5	Spoils Consolidated in Landfill	10,278	CY	$5.0	$51,389
6	GW Transfer Piping and Appurtenances	1	LS	$400,000.0	$400,000
7	GW System Start Up	1	LS	$75,000.0	$75,000
				Post-closure Monitoring Features Installation Subtotal:	**$1,063,889**
				CAPITAL COST SUBTOTAL:	**$1,063,889**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$21,277.78**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$53,194**
				Administration and Construction Oversight(10% of Subtotal Capital Cost):	**$106,389**
				Contingency (20% of Subtotal Capital Cost):	**$212,778**
				TOTAL CAPITAL COST:	**$1,457,528**
II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Groundwater Treatment		**Current Annual Cost**		**NPV Factor**	**NPV**
8	Years 1-5	$100,000	YR	4.84	$483,914
9	Years 6-30	$100,000	YR	20.60	$2,059,538
				Groundwater Treatment	**$2,543,452**
				O&M COST SUBTOTAL:	**$2,543,452**
				Contingency (20% of Subtotal O&M Cost):	**$508,690**
				TOTAL O&M COST:	**$3,052,143**
				TOTAL ESTIMATED COST:	**$4,509,670**
				ROUNDED TO:	**$5,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the projected cost.

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

3 Design includes evaluation of current O&M system and components for use with the proposed system. For this alternative, design costs are specifically included in the cost instead of as a percentage of the construction costs.

4 Groundwater collection trench costs based on similar project experience; square footage based on an approximate estimate.

5 Piping, lift stations, and extraction well costs based on similar project costs.

6 System start up costs based on ten days of prove-out; based on previous project experience.

8 - 9 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-8

Cost Estimate for Remedial Alternatives 2B & 2C Groundwater Subalternative (ii)

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
	Slurry Wall and Hydraulic Control				
I. CAPITAL COSTS					
Groundwater Collection Trench					
1	Pre-construction Field Survey	1	LS	$25,000	**$25,000**
2	Work Planning	1	LS	$150,000	$150,000
3	Design	1	LS	$60,000	$60,000
4	GW Collection Trench & Backfill	55,000	SF	$5.5	$302,500
5	Spoils Consolidated in Landfill	10,278	CY	$5.0	$51,389
6	GW Transfer Piping and Appurtenances	1	LS	$400,000	$400,000
7	GW System Start Up	1	LS	$75,000	$75,000
				Post-closure Monitoring Features Installation Subtotal:	**$1,063,889**
Slurry Wall					
8	Installation of Slurry Wall	220,000	SF	$16	$3,608,000
9	Spoils Consolidated in Landfill	325,925.9	CY	$5	$1,629,630
				Contingent Groundwater Subtotal:	**$5,237,630**
				CAPITAL COST SUBTOTAL:	**$6,301,519**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$126,030**
				Mobilization/Demobilization (5% of Subtotal Capital Cost):	**$315,076**
				Administration and Construction Oversight(10% of Subtotal Capital Cost):	**$630,152**
				Contingency (20% of Subtotal Capital Cost):	**$1,260,304**
				TOTAL CAPITAL COST:	**$8,633,080**
II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Groundwater Treatment		**Current Annual Cost**		**NPV Factor**	**NPV**
10	Years 1-5	$100,000	YR	4.84	$483,914
11	Years 6-30	$100,000	YR	20.60	$2,059,538
				Groundwater Treatment	**$2,543,452**
				O&M COST SUBTOTAL:	**$2,543,452**
				Contingency (20% of Subtotal O&M Cost):	**$508,690**
				TOTAL O&M COST:	**$3,052,143**
				TOTAL ESTIMATED COST:	**$11,685,223**
				ROUNDED TO:	**$12,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

3 Design includes evaluation of current O&M system and components for use with the proposed system. For this alternative, design costs are specifically included in the cost instead of as a percentage of the construction costs.

4 Groundwater collection trench costs based on similar project experience; square footage based on an approximate estimate.

5 Piping, lift stations, and extraction well costs based on similar project costs.

6 System start up costs based on ten days of prove-out; based on previous project experience.

7 Slurry wall costs presented on a square foot basis; include design, site restoration, and other ancillary activities. Costs based on project experience.

8 - 9 Net present value (NPV) factors calculated using the following equation:

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

TABLE 5-9

Cost Estimate for Remedial Alternative 3

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1	Pre-construction Field Survey	1	LS	$9,800	$9,800
2	Air Monitoring Program	700	DAY	$1,500	$1,050,000
3	Temporary Fencing	1	LS	$15,000	$15,000
4	Decontamination Area	1	EA	$35,000	$35,000
5	Temporary Construction Access Roads	1	LS	$80,000	$80,000
6	Clearing & Grubbing	20	AC	$12,000	$240,000
7	Temporary Steel Sheeting (Drive, Extract and Salvage: Means 31 41 16.10 0100)	282	TON	$2,100	$592,200
8	Utility Protection / Relocation	1	LS	$100,000	$100,000
9	Temporary Stormwater Management and Erosion and Sediment	1	LS	$250,000	$250,000
10	Well Abandonment	18	EA	$600	$10,800
				Site Preparation Subtotal:	**$2,382,800**
Excavation					
11	Survey	60	WK	$5,000	$300,000
12	Removal & Segregation of Clean Soil Cover from Bryant HRDL/FRDLs	90,000	CY	$4	$360,000
13	Soil Removal & Processing/Loading into Disposal Containers	1,600,000	CY	$6	$9,600,000
13a	Construction Water Treatment System	400	days	$10,000	$4,000,000
13b	Backfill of Excavation	807,500	CY	$20	$16,150,000
14	Remove Sheet Pile	2,600	LF	$100	$260,000
15	Confirmation Sampling	1,130	EA	$500	$565,000
				Excavation and Consolidation Subtotal:	**$31,235,000**
Offsite Transportation & Disposal					
16	Offsite Transportation & Disposal - TSCA	800,000	TN	$86	$68,800,000
17	Offsite Transportation & Disposal - Non-TSCA	1,800,000	TN	$25	$45,000,000
				Offsite Disposal Subtotal:	**$113,800,000**
Restoration					
18	As-built Survey	6	WK	$5,000	$30,000
19	Topsoil	52,000	CY	$30	$1,560,000
20	Seed & Mulch	65	AC	$2,100	$136,500
				Restoration Subtotal:	**$1,726,500**
				CAPITAL COST SUBTOTAL:	**$149,144,300**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$2,982,886**
				Mobilization/Demobilization (capped at $1.5 million):	**$1,500,000**
				Administration, Design, and Construction Oversight ($1 million a year):	**$5,000,000**
				Contingency (20% of Subtotal Capital Cost):	**$29,828,860**
				TOTAL CAPITAL COST:	**$188,456,046**
III. PERIODIC COSTS				**Discount Rate**	**1.1%**
5-Year Reviews		**Annual Cost**		**Discount Factor**	**Net Present Value**
22	Year 5	$25,000	YR	0.95	$23,669
23	Year 10	$25,000	YR	0.90	$22,409
24	Year 15	$25,000	YR	0.85	$21,216
25	Year 20	$25,000	YR	0.80	$20,087
26	Year 25	$25,000	YR	0.76	$19,018
27	Year 30	$25,000	YR	0.72	$18,006
				TOTAL PERIODIC COST:	**$124,405**
				TOTAL ESTIMATED COST:	**$188,580,451**
				ROUNDED TO:	**$189,000,000**

TABLE 5-9

Cost Estimate for Remedial Alternative 3

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton; WK = Week; MO = Month.

Item Notes (where applicable):

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during COC-containing material handling only (e.g., excavation, consolidation, subgrade preparation).

6. Clearing and grubbing unit cost is based on cutting and chipping of medium to heavily forested area and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL.

11 - 17 Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to offsite disposal. Soil removal and consolidation cost includes excavation and loading of COC-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of

12 Cost for removal and segregation of clean soil cover materials is based on the assumption that approximately 90,000 cubic yards of clean soil cover currently exists on top of the Bryant HRDL/FRDLs, and would be removed and segregated for subsequent use as backfill.

13 Soil removal and processing/loading into disposal containers quantity represents the total quantity of in situ material requiring excavation prior to off-site transportation and disposal. Soil removal cost includes excavation and loading of COC-containing materials, as well as soil processing/handling. Volumes of material removed from each area are presented in table 2-3 of the text.

13b Estimated backfill quantities are based on backfilling excavation areas to maintain onsite ground surface above the water table and to restore offsite areas to the original elevation. Estimated backfill quantities are 202,500 cubic yards from Former Type III Landfill, 108,000 cubic yards from Western Disposal Area, 4,000 cubic yards from the Panelyte Property, 300 cubic yards from Panelyte Marsh, 100 cubic yards from Conrail, 317,500 cubic yards from Bryant HRDLs/FRDLs, 127,500 from Monarch HRDL, 99,500 from Residential and Commercial Properties, and 100 cubic yards from Former Raceway Channel. Quantities will be revised during remedial design.

14 Estimated cost to remove the sheetpile wall assumes that the existing sheetpile wall along the Bryant HRDL/FRDLs will be removed during excavation activities.

15 Confirmation sample quantity assumes that all soil removal areas will be sampled on a 50 foot by 50 foot grid to confirm removal of COC-containing material.

16 Offsite transportation and disposal cost for TSCA material is based on the assumption that approximately 33% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as TSCA material, and all remaining soils will be managed as non-TSCA. Unit rate obtained as verbal quote from Clean Harbors on 2/1/13.

17 Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that approximately 66% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as Non-TSCA material, and all of the excavated soils associated with the Commercial (Goodwill Lawn Area, Goodwill Parking Lot, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age), will also require segregation and offsite disposal as Non-TSCA.

19 Topsoil quantity is based on covering approximately 65 acres of soil removal area with 6 inches of topsoil.

20 Seed and mulch quantity is based on covering the 65 acres of topsoil placed over the soil removal areas.

TABLE 5-10

Cost Estimate for Remedial Alternative 4

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
I. CAPITAL COSTS					
Site Preparation					
1	Pre-construction Field Survey	1	LS	$9,800	$9,800
2	Air Monitoring Program	1400	DAY	$1,500	**$2,100,000**
3	Temporary Fencing	1	LS	$15,000	$15,000
4	Decontamination Area	1	EA	$35,000	$35,000
5	Temporary Construction Access Roads	1	LS	$80,000	$80,000
6	Clearing & Grubbing	20	AC	$12,000	$240,000
7	Temporary Steel Sheeting (Drive, Extract and Salvage: Means 31 41 16.10 0100)	282	TON	$2,100	$592,200
8	Utility Protection / Relocation	1	LS	$100,000	$100,000
9	Temporary Stormwater Management and Erosion and Sedimentation Controls	1	LS	$250,000	$250,000
10	Well Abandonment	18	EA	$600	$10,800
				Site Preparation Subtotal:	**$3,432,800**
Excavation and Consolidation					
11	Survey	60	WK	$5,000	$300,000
12	Soil Removal & Onsite Transport to Temporary Staging Area(s)	1,600,000	CY	$6.00	$9,600,000
12a	Construction Water Treatment System	400	days	$10,000	$4,000,000
13	Removal & Segregation of Clean Soil Cover from Bryant HRDL/FRDLs	90,000	CY	$4.00	$360,000
14	Loading & Onsite Transport of Soils from Temporary Staging Area(s) to Consolidation Area(s) for Placement	1,200,000	CY	$8.00	$9,600,000
15	Soil Removal & Processing/Loading into Disposal Containers	500,000	CY	$8.00	$4,000,000
16	Remove Sheet Pile Wall	2,600	LF	$110	$286,000
17	Confirmation Sampling	1,130	EA	$500	$565,000
				Excavation and Consolidation Subtotal:	**$28,711,000**
Offsite Transportation & Disposal					
18	Offsite Transportation & Disposal - Non-TSCA	780,000	TN	$25	$19,500,000
				Offsite Disposal Subtotal:	**$19,500,000**
Base Liner System					
19	Grade Verification Surveys	16	WK	$50,000	$800,000
20	Soil Grading Layer (Select Fill)	800,000	CY	$20	$16,000,000
21	Secondary Geosynthetic Clay Liner (GCL)	280,000	SY	$5	$1,400,000
22	Secondary 40-Mil Flexible Membrane Liner (FML)	280,000	SY	$8	$2,100,000
23	Primary GCL	280,000	SY	$5	$1,400,000
24	Primary FML	280,000	SY	$8	$2,100,000
25	Geosynthetic Drainage Composite (GDC) Layer	280,000	SY	$5	$1,400,000
26	Soil Protection/Drainage Layer	78,000	CY	$20	$1,560,000
27	Pumpable Sump System	1	LS	$500,000	$500,000
28	Leak Detection System	1	LS	$100,000	$100,000
				Base Liner System Subtotal:	**$27,360,000**
Final Cover System					
29	Grade Verification Surveys	16	WK	$5,000	$80,000
30	Soil Grading Layer (Select Fill)	39,000	CY	$20	$780,000
31	Geotextile Separation Layer (8-oz/sy)	280,000	SY	$2.50	$700,000
32	Gas Venting Layer (Sand)	78,000	CY	$20.00	$1,560,000
33	Passive Gas Vents	60	EA	$1,000	$60,000
34	30-mil PVC Liner (or equivalent)	280,000	SY	$7.50	$2,100,000
35	Geotextile Cushion Layer (16-oz/sy)	280,000	SY	$4.50	$1,260,000
36	Soil Protection / Drainage Layer (Sand)	156,000	CY	$20.00	$3,120,000
37	Topsoil Layer	39,000	CY	$30	$1,170,000
38	Seed & Mulch	48	AC	$2,100	$100,800
				Final Cover System Subtotal:	**$10,930,800**

TABLE 5-10

Cost Estimate for Remedial Alternative 4

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
Permanent Stormwater Management					
39	Vegetated Swales	16,000	LF	$15	$240,000
40	Riprap-lined Swales	7,000	LF	$100	$700,000
41	Riprap Slope Protection	1	LS	$400,000	$400,000
42	Culverts	1,500	LF	$30	$45,000
43	Subsurface Drain Piping	7,000	LF	$45	$315,000
44	Stormwater Basins	5	EA	$80,000	$400,000
				Permanent Stormwater Management Subtotal:	**$2,100,000**
Restoration					
45	As-built Survey	6	WK	$5,000	$30,000
46	Backfill	80,000	CY	$20	$1,600,000
47	Topsoil	14,000	CY	$30	$420,000
48	Seed & Mulch	17	AC	$2,100	$35,700
49	Permanent Gravel Access Roads	1	LS	$250,000	$250,000
				Restoration Subtotal:	**$2,335,700**
Post-closure Monitoring Features Installation					
50	Installation of Permanent Gas Monitoring Probes	6	EA	$5,000	$30,000
51	Installation of Perimeter Gas Venting Trenches	14,500	SF	$30	$435,000
52	Installation of Post-closure Groundwater Monitoring Well Network	20	EA	$6,000	$120,000
				Post-closure Monitoring Features Installation Subtotal:	**$585,000**
				CAPITAL COST SUBTOTAL:	**$94,955,300**
				Subcontractor Performance and Payment Bonds (2% of Subtotal Capital Cost):	**$1,899,106**
				Mobilization/Demobilization:	**$3,000,000**
				Administration, Design, and Construction Oversight ($1 million a year):	**$10,000,000**
				Independent Construction Quality Assurance (5% of Liner System Capital Costs):	**$1,914,540**
				Contingency (20% of Subtotal Capital Cost):	**$18,991,060**
				TOTAL CAPITAL COST:	**$130,760,006**

II. OPERATION AND MAINTENANCE (O&M) COSTS				**Discount Rate**	**1.1%**
Post-closure Inspections & Maintenance		**Annual Cost**		**Discount Factor**	**Net Present Value**
53	Years 1-5	$100,000	YR	4.84	$483,914
54	Years 6-30	$50,000	YR	20.60	$1,029,769
				Post-closure Inspections & Maintenance Subtotal:	**$1,513,683**
Post-closure Landfill Gas Monitoring & Reporting					
55	Years 1-5	$4,000	YR	4.84	$19,357
56	Years 6-30	$2,000	YR	20.60	$41,191
				Post-closure Landfill Gas Monitoring & Reporting Subtotal:	**$60,547**
Post-closure Groundwater Sampling & Reporting					
57	Years 1-5	$200,000	YR	4.84	$967,829
58	Years 6-30	$100,000	YR	20.60	$2,059,538
				Post-closure Groundwater Sampling & Reporting Subtotal:	**$3,027,367**
				O&M COST SUBTOTAL:	**$4,601,597**
				Contingency (20% of Subtotal O&M Cost):	**$920,319**
				TOTAL O&M COST:	**$5,521,917**

III. PERIODIC COSTS				**Discount Rate**	**1.1%**
5-Year Reviews		**Annual Cost**		**Discount Factor**	**Net Present Value**
59	Year 5	$25,000	YR	0.95	$23,669
60	Year 10	$25,000	YR	0.90	$22,409
61	Year 15	$25,000	YR	0.85	$21,216
62	Year 20	$25,000	YR	0.80	$20,087
63	Year 25	$25,000	YR	0.76	$19,018
64	Year 30	$25,000	YR	0.72	$18,006

TABLE 5-10

Cost Estimate for Remedial Alternative 4

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
				TOTAL PERIODIC COST:	**$124,405**
				TOTAL ESTIMATED COST:	**$136,406,328**
				ROUNDED TO:	**$136,000,000**

General Notes:

This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the projected cost.

Unit prices are based on 2013 dollars.

All volumes represent in-place measures.

Where not otherwise noted, unit cost is based on past project experience.

Mobilization/Demobilization includes, but is not necessary limited to, transportation of personnel, equipment, and materials to and from the OU, temporary utilities and services (i.e., electrical, water, telephone, sanitary), construction trailers, etc. (i.e., with winter shutdown).

CY = Cubic Yard; LF = Linear Feet; LS = Lump Sum; SY = Square Yard; AC = Acre; EA = Each; TN = Ton WK = Week; MO = Month.

Item Notes (where applicable):

1. Pre-construction survey includes costs associated with performing an aerial survey, supplemental field survey, in-field property boundary delineations, field marking OU features to be protected (e.g., monitoring wells), and cross sections within Portage Creek prior to construction.

2. Air monitoring unit cost assumes that monitoring activities are required during COC-containing material handling only (e.g., excavation, consolidation, subgrade preparation).

6. Clearing and grubbing unit cost is based on cutting and chipping of medium to heavily forested area and grubbing of stumps and other miscellaneous debris within the areas subject to consolidation and final cover system.

7. Temporary steel sheeting cost estimate is based on the assumption that approximately 1,200 linear feet of 15-foot long steel sheeting will be installed to facilitate earthwork activities along the bank of Portage Creek adjacent to the Monarch HRDL.

12 Soil removal and consolidation quantity represents the total quantity of in-situ material requiring excavation prior to consolidation within the Former Type III Landfill, Western Disposal Area, and Monarch HRDL consolidation areas. Soil removal and consolidation cost includes excavation and loading of COC-containing materials, onsite transport to placement area within the consolidation areas, and placement and compaction in 12-inch lifts within the consolidation areas. Estimated quantities are based on removal and consolidation of approximately 405,000 cubic yards of material from the Former Type III Landfill, 270,000 cubic yards from the Western Disposal Area, 4,000 cubic yards from the Panelyte Property, 300 cubic yards from Panelyte Marsh, 100 cubic yards from the Conrail Property, 635,000 cubic yards from Bryant HRDLs/FRDLs, 170,000 cubic yards from the Monarch HRDL, 100 yards from Former Raceway Channel, and approximately 99,500 cubic yards of material from Residential and Commercial Properties.

16 Estimated quantity and cost is not based on calculation, rather it is an estimate based on site topography and the potential for sheet pile removal based on slope stability considerations. Lineal footage and costs to be determined during design phase.

17 Confirmation sample quantity assumes that all soil removal areas will be sampled on a 50 foot by 50 foot grid to confirm removal of COC-containing material.

18 Offsite transportation and disposal cost for Non-TSCA material is based on the assumption that approximately 66% of the soil removed from the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL will require offsite transportation and disposal as Non-TSCA material, and all of the excavated soils associated with the Commercial (Goodwill Lawn Area, Goodwill Parking Lot, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age), will also require segregation and offsite disposal as Non-TSCA. Volumes of material to be removed are presented in Table 2-3 of the text.

19 - 38 Final cover quantities are based on the following estimated areas: Former Type III Landfill - 10 acres, Western Disposal Area - 12 acres, Bryant HRDLs/FRDLs - 20.7 acres, and Monarch HRDL - 5.2 acres.

20 Soil grading layer cost estimate is based on an assumed 10-foot-thick layer of select fill covering the entire areas subject to base liner installation, as required to ensure that the base liner system is a minimum of 10 feet above the groundwater table.

21 Secondary geosynthetic clay liner (GCL) cost estimate assumes utilizing a GCL as a soil-clay substitute covering the entire base liner system areas, and includes an additional 20% material quantity to account for overlap and wrinkles.

22 Estimated cost for secondary 40-mil flexible membrane liner (FML) is based on the assumption that an impermeable liner will be placed as part of the base liner of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL. This quantity includes an additional 20% material quantity to account for overlap and wrinkles.

23 Primary GCL cost estimate assumes using a GCL as a soil-clay substitute covering the entire base liner system areas, and includes an additional 20% material quantity to account for overlap and wrinkles.

24 Estimated cost for primary 40-mil FML is based on the assumption that an additional impermeable liner will be placed as part of the base liner of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL. This quantity includes an additional 20% material quantity to account for overlap and wrinkles.

25 Estimated cost for installation of geosynthetic drainage composite (GDC) layer is based on the assumption that a GDC layer will be placed as part of the base liner systems of the Bryant HRDL/FRDLs, Former Type III Landfill, Western Disposal Area, and Monarch HRDL. The estimated quantity includes an additional 20% material quantity to account for overlap and wrinkles.

26 Soil protection/drainage layer consists of a 1-foot-thick layer of sand covering the entire base liner system area.

TABLE 5-10

Cost Estimate for Remedial Alternative 4

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Item No.	Description	Estimated Quantity	Unit	Unit Cost (Labor and Materials)	Estimated Cost
30	Soil grading layer cost estimate is based on an assumed 6-inch-thick layer of select fill covering the entire consolidation/cover system areas and is the first layer of the earthen cover system.				
31	Geotextile separation layer cost estimate assumes utilizing a non-woven geotextile covering the entire cover system areas, and includes an additional 20% material quantity to account for overlap and wrinkles. Unit cost is based on information provided by geotextile manufacturer.				
36	Soil protection/drainage layer consists of a 1-foot-thick layer of sand covering the entire cover system area.				
37	Topsoil layer consists of a 6-inch-thick layer of topsoil covering the entire cover system areas.				
38	Seed and mulch cost estimate is based on seeding and mulching the entire area subject to consolidation/final cover system.				
39	Total length of the vegetated swale is based on a conceptual cover system layout prepared for cost estimating purposes only.				
40	Total length of the riprap-lined swale is based on a conceptual cover system layout prepared for cost estimating purposes only.				
42	Total length of culvert piping is based on a conceptual cover system layout prepared for cost estimating purposes only.				
43	It is anticipated that subsurface drainage would be installed at the interface between the consolidation area and the existing Bryant HRDLs and FRDLs liner system. Liner system grades at the interface are assumed to slope downward on a 4 on 1 slope forming a v-notch channel containing the subsurface drainage piping.				
44	Stormwater basin unit cost represents an average per basin cost, which was developed from a conceptual stormwater basin configuration.				
45 - 49	Restoration quantity assumes approximately 17 acres of soil removal area, located outside the limits of capping, as specified in the following: Former Type III Landfill - 3.6 acres, Western Disposal Area - 3.6 acres, Bryant HRDL/RDL - 1.5 acres, Monarch HRDL - 1.6 acres, commercial properties - 5.3 acres and Residential/MHLLC-Owned properties including Golden Age) - 1.5 acres.				
46	The estimated cost for backfill assumes that the voids created by removal of PCB-containing soil from the Commercial (Goodwill Lawn Area, Goodwill Parking Lots, Consumers Power, and Alcott Street Parking Lot) and Residential/MHLLC Properties (including Golden Age) will be replaced with clean backfill to within 6 inches of pre-existing grades (allowing for subsequent topsoil placement).				
47	Topsoil quantity is based on covering approximately 17 acres of disturbed area, located outside the limits of capping, with 6 inches of topsoil.				
48	Seed and mulch quantity is based on covering the 17 acres of topsoil placed over the outlying soil removal areas, Monarch landfill area, and consolidation area as necessary to promote vegetative growth.				
49	Permanent access road quantity based on an assumed 8,000 linear feet of newly constructed road that will be required to access various portions of the cover system area for maintenance purposes.				
53 - 58	Net present value (NPV) factors calculated using the following equation:				

$$NPV = I_0 + \frac{I_1}{1+r} + \frac{I_2}{(1+r)^2} + \ldots + \frac{I_n}{(1+r)^n}$$

r = Discount rate (expressed as decimal)

n = Number of years from present

SECTION 6

Comparative Analysis of Remedial Alternatives

Each potential remedial alternative identified in Section 4 was evaluated in Section 5 against seven of the nine criteria in accordance with CERCLA guidance. The remaining criteria, state and community acceptance, will be evaluated in the ROD once formal comments on the FS and proposed plan have been received.

Section 6 provides a comparative analysis of the remedial alternatives. The following subsections summarize the primary advantages and disadvantages of each proposed alternative with regard to the seven criteria identified in Section 5. As described in CERCLA FS assessment guidance (USEPA 1988), "The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs the decision maker must balance can be identified." A summary table showing each remedial alternative relevant to the applicable criteria is included as Table 6-1.

PCBs were identified earlier in this report as the primary driver for cleanup at OU1 and other COCs are collocated with the PCBs. It is expected that by addressing PCBs in soil, sediment, and residuals, the remaining COCs will be addressed. For that reason, this section focuses mainly on the remediation of PCBs.

6.1 Overall Protection of Human Health and the Environment

Alternatives 2, 3, and 4 are each expected to be effective long-term remedies for OU1. Under these alternatives, the three RAOs would be achieved and ARARs would be met. As discussed in Sections 1.4, 1.6, and 1.11, the primary exposure pathways at OU1 are associated with the following:

- Consumption of fish
- Direct contact with exposed materials with COCs above PRGs
- Inhalation of dust and volatile emissions from floodplain soils and consolidated residuals
- Ingestion of or direct contact with groundwater impacted above PRGs

Transport mechanisms that may result in completed exposure pathways include the following:

- Transport of groundwater impacted by contaminated material
- Surface water runoff
- Wind dispersion of exposed materials with COCs above PRGs
- Erosion of contaminated materials to Portage Creek and Kalamazoo River System

The sources of PCBs and relevant COCs to groundwater, surface water, air, and sediments will be reduced by addressing PCBs in soils and sediments, because the PCBs are bound to the paper waste, which is found in isolation and intermixed into soils and sediments.

PCBs are located in the surface and subsurface soils and sediments onsite and in outlying areas. PCBs tend to adhere strongly to organic solids, such as those found in paper residuals and have a low solubility in water. The residuals are found on their own and intermixed into soils and sediments. The physicochemical properties of PCBs make them relatively immobile to leaching; however, the exposed soils and sediments are still susceptible to erosion and dust generation.

The groundwater and seep samples with elevated PCB concentrations were generally located in areas of OU1 that were not addressed by IRM activities. The areas would be addressed in each of the Alternatives 2 through 4. Alternatives 2 and 4 include capping to prevent infiltration of surface water through the consolidated soils and to prevent leaching and colloidal transport. Under current conditions, PCBs are meeting GSI levels prior to Portage Creek, so the addition of groundwater collection subalternatives to Alternative 2 options would not significantly increase their overall protectiveness. Alternative 3 includes complete removal and offsite disposal.

Alternative 1 would provide no improved protection over the current conditions, would provide no risk reduction, and would not be protective of human health or the environment. No RAOs would be achieved by Alternative 1.

The overall protectiveness to human health and the environment is similar for each active remedial alternative as long as all elements of the remedy, including O&M and monitoring, are properly maintained, RAOs 1 through 3 would be achieved for Alternatives 2, 3, and 4, the significant difference being that with increasing complexity of remedy, there are increased short-term risks.

6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 1 would not achieve ARARs. The relevant action and location-specific ARARs vary among Alternatives 2, 3, and 4. Implementation of Alternative 2 options, 3 and 4 would result in the achievement of the identified ARARs.

6.3 Long-term Effectiveness and Permanence

Under Alternative 1, the requirements to reduce exposure or associated risk to acceptable levels, achieve an acceptable degree of protectiveness, and appropriately manage/operate disposal areas would not be achieved. With the exception of Alternative 1, each of the remaining alternatives would be expected to meet RAOs 1 through 3 and provide long-term effectiveness and permanence once the RAOs are met. The active alternatives are combinations of proven and reliable remedial processes, and the potential for failure of any individual component is low.

Alternative 2 options would achieve long-term effectiveness through onsite containment of the material with COCs above PRGs as a primary component of the remedy, with O&M, monitoring, and institutional controls to collectively ensure and verify the permanence of the remedy. Alternative 2C does not significantly increase the long-term effectiveness of the remedy through incineration of excavated material with PCB concentrations greater than 500 mg/kg because capping prevents direct contact and erosion and the PCBs are already largely immobile in the waste. Only materials excavated as a result of consolidation would be incinerated, residuals with concentrations greater than 500 mg/kg currently located in the Bryant HRDL/FRDL would remain. Under current conditions, PCBs do not appear to be migrating outside the waste via groundwater, so the addition of groundwater collection subalternatives to Alternative 2 options would not significantly increase their long-term protectiveness. Alternative 3 would achieve long-term effectiveness and permanence by removing all material with COC exceedances from OU1 and disposing of it at offsite solid waste landfills and TSCA facilities. Alternative 4 would achieve long-term effectiveness and permanence by placing the PCB material into containment cells constructed onsite with O&M, monitoring, and institutional controls.

Under Alternative 3, no long-term O&M or monitoring would be required onsite with the exception of areas where waste is left in place because of the proximity to buildings. Materials with COC concentrations above relevant PRGs would be excavated and disposed of offsite. The large-scale removal and offsite disposal of materials presented in Alternatives 3 provides an added degree of permanence at OU1 through removal.

Alternative 2 options are proven technologies that meet the requirements for effectiveness and permanence. Alternative 3 and 4 provide an added level of protectiveness because wastes are disposed of in lined containment cells. The main difference between Alternatives 3 and 4 is that the waste is moved and managed offsite in Alternative 3. The long-term monitoring and maintenance components to be implemented in conjunction with institutional controls under Alternative 2 options, or Alternative 4 would provide the necessary mechanisms to verify that each remedy is performing as anticipated over time. As a result, Alternative 2, options 3 and 4, are expected to provide effective, permanent remedies.

6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2C is the only alternative that would result in a reduction of toxicity or volume by treatment with the offsite incineration of a portion of excavated soils. Subalternatives (i) and (ii) provide a reduction in the contaminant volume in groundwater; however, minimal contaminant mass is present in the groundwater and is not seen outside of the waste. Treatment is not a component of any of the other remedial alternatives carried forward.

Section 300.430(a)(iii)(B) of the National Oil and Hazardous Substances Pollution Contingency Plan contains an expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat where treatment is impracticable. Alternative 1 does not reduce the toxicity, mobility, or volume of COC-impacted materials. Alternatives 2A, 2B, and 4 would reduce the mobility of COCs through isolation and containment. Only Alternative 2C would result in a reduction of toxicity or volume by treatment.

TABLE 6-1
Comparative Analysis of Alternatives
OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

Alternative	Description	Overall Protection	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility or Volume through Treatment	Short-term Effectiveness	Implementability	Cost
Alternative 1	**No action**	Not protective. No action would be taken.	Would not meet ARARs	Not effective. Site conditions would remain the same.	No reduction of toxicity, mobility, or volume.	No worker risks. No action to be taken.	Implementable as no action would be taken.	$120,000
Alternative 2	**Consolidation and capping**							
2A	Construct caps on both Monarch and Operations areas	Protective. Remaining exposed contamination would be covered and contained. Infiltration of surface water would be minimized.	Meets ARARS.	Effective.	No reduction of toxicity, mobility, or volume would be achieved.	Implementation over 2-year period, most effective of active alternatives. Worker risk associated with dermal contact, inhalation, and ingestion. Risks are controllable. Community impacts associated dust, noise, and traffic.	Proven technology that has been implemented at similar OUs.	$43 million
2B	Consolidate Monarch within Operations areas	Protective. Remaining exposed contamination would be covered and contained. Consolidation of the Monarch HRDL within the operations area would reduce the amount of monitoring required.	Meets ARARS.	Effective.	No reduction of toxicity, mobility, or volume would be achieved.	Implementation over 2-year period, slightly longer than 2A. Worker risk associated with dermal contact, inhalation, and ingestion. Risks are controllable. Community impacts associated dust, noise, and traffic.	Proven technology that has been implemented at similar OUs. Combining Monarch on the Operations Area would reduce the footprint of contamination.	$41 million
2C	Consolidate Monarch within operations areas and transport excavated soils with PCBs >500 mg/kg offsite for incineration	Protective. Remaining exposed contamination would be covered and contained. Consolidation of the Monarch HRDL within the operations area would reduce the amount of monitoring required. Offsite incineration of some of the highest PCB concentrations would be slightly more protective.	Meets ARARs	Effective.	Reduction of toxicity and volume through treatment of a portion of the material.	Implementation over 2-year period, slightly longer than 2A and 2B. Worker risk associated with dermal contact, inhalation, and ingestion due to increased management with characterization and segregation. Risks are controllable. Community impacts associated dust, noise, traffic, and offsite transportation of contaminated materials.	Proven technology that has been implemented at similar OUs. Combining Monarch on the operations area would reduce the footprint of contamination. TSCA-permitted incinerators are limited quantity. Identifying, segregating and shipping, make 2C more difficult to implement.	$62 million
Subalternative (i)	Groundwater collection and treatment system	Protective. Achieves RAO 3 with collection and treatment of potentially impacted groundwater.	Meets ARARs	Effective.	Provides some reduction of volume through treatment of PCBs in groundwater. However, minimal contaminant mass is present in the groundwater.	Manageable risk associated with the installation of wells and construction of treatment system.	Proven technology.	$4.6 million (2A) or $4.5 million (2B and 2C)
Subalternative (ii)	Groundwater collection and treatment system with slurry wall	Achieves RAO 3 with collection and treatment of potentially impacted groundwater, but may create mounding or otherwise alter groundwater flow.	Meets ARARs	Effective.	Provides some reduction of volume through treatment of PCBs in groundwater. However, minimal contaminant mass is present in the groundwater.	Increased short-term risks to construction worker and environment over subalternative (i) during installation of the slurry wall. Community impacts from dust, noise and traffic associated with the slurry wall construction.	Proven technology. Implementation may result in groundwater mounding or short-circuiting around the barrier if operation of the groundwater treatment system ceased.	$13 million (2A) or $12 million (2B and 2C)

TABLE 6-1
Comparative Analysis of Alternatives
OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

Alternative	Description	Overall Protection	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility or Volume through Treatment	Short-term Effectiveness	Implementability	Cost
Alternative 3	**Total Removal and Offsite Disposal**	Protective. Contamination would be disposed of at an approved landfill facility both hazardous and non-hazardous.	Meets ARARS.	More effective than Alternative 2 due to removal from OU1. No cover maintenance or source for potential groundwater impacts.	No reduction of toxicity, mobility, or volume would be achieved. Volume may be increased if soils require dewatering by addition of cement.	Implementation over 5-year period. Worker risk associated with dermal contact, inhalation and ingestion would occur over a longer period of time. Risks are controllable. Community impacts associated dust, noise, and traffic.	Proven technology, landfill space in the area could be limited requiring the hauling of waste a significant distance from OU1.	$189 million
Alternative 4	**Encapsulation Containment System**	Protective. Little advantage achieved by construction of the liner. Compacted waste can achieve 1×10^{-7} centimeters per second hydraulic conductivity on its own limiting groundwater flow through the material.	Meets ARARS.	More effective than Alternative 2. The source material is fully encapsulated further minimizing potential for groundwater impacts.	No reduction of toxicity, mobility, or volume would be achieved.	Implementation over 10-year period. Worker risk associated with dermal contact, inhalation, and ingestion would occur over a longer period of time. Risks are controllable. Community impacts associated dust, noise is the least short-term effective alternative.	Proven technology.	$136 million

6.5 Short-term Effectiveness

The evaluation of short-term effectiveness criterion are primarily related to the area and volume of COC-containing materials addressed in each alternative, the time necessary to implement the remedy, potential risks to workers, and potential impacts to the community during construction. Short-term effectiveness is summarized in Table 6-2.

TABLE 6-2
Summary of Short-term Effectiveness Considerations
OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

Alternative	Total Area	Total Volume of COC-Containing Materials Excavated	Duration	Worker Risks	Community Impacts
Alternative 1	No areas addressed	No volume of impacted PCB-containing materials addressed	No time period to implement	No worker risks from implementation as no action is taken.	Potential offsite migration of COC-containing materials.
Alternative 2A	65 acres	350,000 yd^3	Approximately 2 years	Least of the active alternatives; managed by health and safety plan.	Associated with dust, noise, and truck traffic.
Alternative 2B	65 acres	479,000 yd^3	Approximately 2 years	Slightly increased due to moving Monarch HRDL; managed by health and safety plan.	Slight increase; associated with dust, noise, and truck traffic.
Alternative 2C	65 acres	479,000 yd^3	Approximately 2 years	Greater than 2A and 2B due to potential exposure during characterization and transportation.	Greater than 2A and 2B due to additional management for characterization and offsite transport.
Subalternative (i)	N/A	N/A	Concurrent with Alternative 2 Options, but indefinite O&M	Risks are easily managed by health and safety plan. Continued risks present with operation and maintenance of treatment system.	Slight increase over Alternative 2 options during construction due to well installation and treatment system construction.
Subalternative (ii)	N/A	N/A	Concurrent with Alternative 2 Options, but indefinite O&M	Greater risks than subalternative (i) due to construction of slurry wall. Similar O&M risks.	Slight increase over Alternative 2 options during construction due to well installation and treatment system construction. Greater than subalternative (i) due to slurry wall construction.
Alternative 3	65 acres	1,600,000 yd^3	5 years	Greater than Alternative 2 given the area/volume of targeted material; Increased travel for disposal and increased project duration.	Greater than Alternative 2; associated with noise, dust, and particularly increased truck traffic, which would average 115 trips daily in and out of OU1 for the duration of the project. Greatest number of miles driven due to volume transported to disposal facilities with limited locations.

TABLE 6-2
Summary of Short-term Effectiveness Considerations
OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

Alternative	Total Area	Total Volume of COC-Containing Materials Excavated	Duration	Worker Risks	Community Impacts
Alternative 4	65 acres	1,600,000 yd^3	10 years	Greater than Alternatives 2 and 3 given the area/volume of targeted material and significantly increased project duration.	Greater than Alternatives 2 and 3; associated with noise and dust over the longest project duration. Slightly fewer truck trips than Alternative 3, but 1/3 of the miles outside OU1 due to decreased volume transported to disposal facilities.

With the exception of Alternative 1, all the alternatives with active remedial components would have some short-term impacts, including increased noise from construction vehicles, the potential for airborne dust releases, increased traffic in the vicinity of OU1, increased wear on local roads, increased potential for workers to come in contact with PCB-containing materials, and other risks associated with construction work. Alternative 2 options, require the least amount of disturbance and shortest construction time. The impacts can be effectively addressed through implementing a project-specific health and safety plan, keeping excavation areas properly wetted, planning truck routes to minimize disturbances to the surrounding community, and other standard best management practices. The addition of groundwater subalternatives to Alternative 2 options would result in greater short-term impacts as they increase the construction period and the amount of local truck traffic associated with site activities. Installation of the subalternatives would also require more mitigation to prevent releases to Portage Creek during installation.

Alternatives 3 and 4 present greater short-term impacts because of the amount of materials required to be moved and the increased construction duration. The project duration for the alternatives is longer than Alternative 2 options, increasing both construction-related and exposure risks to workers. The additional volume of materials to be handled in Alternatives 3 and 4 also result in an increase in truck traffic near OU1 during the project. During the implementation of Alternative 3, there would be an average of 115 truck trips per day, year-round, for approximately 5 years. During the excavation and backfilling work under Alternative 4, there would be an average of 90 trips per day into and out of OU1 for approximately 6 years. The increase in truck traffic results in an increased risk for vehicular accidents.

There are additional qualitative impacts to the local community, such as noise and dust, for a period of 5 years (Alternative 3) to 10 years (Alternative 4), which will place an increased burden on the community. There are no short-term impacts associated with construction or implementation for Alternative 1; however, since existing measures in place to control access to OU1 would not be maintained, there could be an increased risk of direct exposure over the short term to individuals who trespass and come into contact with surficial materials containing COCs above the PRGs.

6.6 Implementability

The primary remedial components of Alternative 2, options 3 and 4, are proven, readily implementable, have been used successfully as part of other environmental cleanup projects, and they are expected to be reliable over the long term. All the alternatives are administratively implementable, and although no permits would be required, the substantive applicable requirements of federal and state regulations would be met. The addition of groundwater subalternatives (i) or (ii) to Alternative 2 options would not be significantly more difficult to implement. There could be long-term implementability issues with subalternative (ii) as installation of a slurry wall could create problems associated groundwater mounding.

Alternative 2, options 3 and 4, could be completed using readily available conventional earth-moving equipment, and most of the necessary services and construction materials are expected to be readily available. Qualified commercial contractors with experience at other areas of the Kalamazoo River Superfund Site are available locally to perform the work.

Alternatives 3 and 4 are more difficult to implement due to different constraining conditions. For Alternative 3, the availability of solid waste and/or TSCA landfills to accept the volume of materials to be disposed of offsite would be a limiting factor in terms of construction progress and overall cost. The limited staging area available for excavated materials during construction of the containment cells would be a limiting factor for Alternative 4. Alternatives 3 and 4 are also more difficult to implement because of the requirement to characterize and evaluate material for disposal or beneficial onsite reuse due to the heterogeneity within the HRDLs and FRDLs and variability of the PCB concentrations.

6.6.1 Disposal Availability

There are a very limited number of TSCA-permitted incinerators nationwide. As a result, Alternative 2C incorporates travel a minimum of 1,200 miles by rail to an incinerator for disposal. While still implementable, the long transport distances result in increased short-term risks and escalated costs.

There are few solid waste landfills in southwest Michigan that are available to accept PCB-containing material, regardless of whether that material meets solid waste regulatory requirements. The facilities commonly have limits on disposal capacity and disposal rates that may affect the timely completion of Alternative 3 and 4 in which a large volume of PCB- and other COC-containing material would be disposed of offsite. It is also possible that the combined disposal capacity in all of the nearby solid waste facilities and TSCA landfills would be insufficient for the large volumes of PCB-containing material proposed for disposal under Alternative 3. The result could be increased transport distances for offsite disposal, and consequentially increased risks and costs.

6.6.2 Construction of the Containment Cells

Additional implementability challenges associated with the construction of the containment cells in Alternative 4 include sequencing and space constraints, developing a plan for excavating 1,600,000 yd^3 of COC-containing materials, constructing the full-encapsulation disposal cells, and replacing the excavated materials in the cells. As each containment cell is sequentially constructed, a successively smaller area will be available onsite for staging of clean materials and temporary storage of COC-containing materials. Eventually, onsite capacity will be depleted, and a substantial volume of material will have to be disposed of offsite. Approximately 25 percent of the soils targeted for excavation and placement in the Former Operational Areas and all of the soils excavated from the offsite areas would be volumetrically displaced, resulting in 500,000 yd^3 of materials being transported offsite for disposal, which would have a significant impact on both the implementation and cost of this alternative.

The control and management of surface water runoff from the temporarily stored COC-containing materials also will become increasingly challenging as less area is available for the operations under Alternative 4.

There may be local community resistance to trucks transporting COC-containing materials from OU1 over local roads en route to offsite disposal facilities under Alternatives 3 and 4, which are estimated to take 5 years and have 6 years of traffic impacts, respectively.

There are no technical or administrative implementability issues associated with Alternative 1 because no active remediation would take place.

6.7 Cost

The costs for the range of alternatives and subalternatives presented in this FS are summarized in Table 6-3. The detailed estimates and associated assumptions are presented in Tables 5-1 through 5-10. The cost estimates are consistent with FS-level of estimation, with an accuracy of +50 to -30 percent. A final cost estimate would be developed and refined during the remedial design process after the selection of a recommended remedy. Alternative 1 has no associated capital or O&M costs since there would be no further actions taken, but does require 5-year reviews as shown with periodic costs.

TABLE 6-3
Summary of Remedial Alternative Costs
OU1 Feasibility Study Report—Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site

Alternative	Estimated Capital Cost	Estimated O&M Cost	Estimated Periodic Cost	Total Present-worth Cost
Alternative 1	$0	$0	$120,000	$120,000
Alternative 2A	$36,000,000	$7,400,000	$120,000	$43,000,000
Subalternative (i)	$1,600,000	$3,100,000	$0	$4,600,000
Subalternative (ii)	$10,000,000	$3,100,000	$0	$13,000,000
Alternative 2B	$36,000,000	$5,500,000	$120,000	$41,000,000
Subalternative (i)	$1,500,000	$3,100,000	$0	$4,500,000
Subalternative (ii)	$8,600,000	$3,100,000	$0	$11,700,000
Alternative 2C	$57,000,000	$5,500,000	$120,000	$62,000,000
Alternative 3	$188,000,000	$0	$120,000	$189,000,000
Alternative 4	$131,000,000	$5,500,000	$120,000	$136,000,000

Note: Costs for subalternative (i) and (ii) for Alternative 2C are the same as Alternative 2B.

SECTION 7
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Appendix A
Supplemental Groundwater Investigation Report

ARCADIS
Infrastructure, environment, buildings

Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site

Supplemental Groundwater Investigation Report

Allied Operable Unit, Kalamazoo, Michigan

October 2009

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DRAFT FOR FEDERAL AND STATE REVIEW

Supplemental Groundwater Investigation Report

Allied Operable Unit, Kalamazoo, Michigan

Allied Paper, Inc./Portage Creek/ Kalamazoo River Superfund Site

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Tables

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Attachments

1. Introduction

On behalf of Millennium Holdings, LLC (MHLLC[1]), ARCADIS has completed Supplemental Groundwater Investigation activities at the Allied Operable Unit (Allied OU) of the Kalamazoo River Superfund Site to obtain additional information regarding the potential flow paths of groundwater from the Allied OU. These activities were completed at the request of and with the approval of the United States Environmental Protection Agency (USEPA). The primary goal of the supplemental work was to address concerns expressed by the City of Kalamazoo (the City) in their September 17, 2008 correspondence, titled *Interim Technical Responses to the Allied Paper Operable Unit, Kalamazoo, Michigan, Remedial Investigation Report* (City of Kalamazoo 2008a), particularly with regard to the potential for polychlorinated biphenyls (PCBs) present at the Allied OU to migrate to the City's drinking water wells. In its document, among other things, the City expressed the concern that this issue was not adequately addressed in the Remedial Investigation (RI) Report for the Allied OU, which was issued by the Michigan Department of Environmental Quality (MDEQ) in March 2008 (MDEQ 2008a). In subsequent discussions, the City also expressed concern that should there be a direct flow path for groundwater from the Allied OU to the City's Central Well Field, the public water supply might be affected by inorganic constituents that have been detected in samples of groundwater collected from certain shallow monitoring wells at the Allied OU.

To better understand the concerns of City representatives, ARCADIS and MHLLC convened a series of teleconferences and meetings, concluding with a meeting on April 14, 2009, attended by the USEPA, MDEQ, and City and community representatives. These discussions resulted in the development of the proposed scope of work, presented in the *Groundwater Evaluation and Work Plan for Supplemental Investigation* (Work Plan), dated April 28, 2009 (ARCADIS 2009). Drafts of the Work Plan were shared and discussed among key stakeholders, including the City. The Work Plan was approved by the USEPA on May 26, 2009, and field activities were subsequently implemented in late June and early July 2009. The preliminary indications of the investigation were presented to the USEPA, MDEQ, the City, and the public on July 28, 2009. This report presents the data and findings of the Supplemental Groundwater Investigation.

1.1 Purpose

The overall purpose of the Supplemental Groundwater Investigation activities described in this report was to address the City's concern that constituents present in the shallow

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[1] LeMean Property Holdings Corporation (LeMean) owns the Kalamazoo River Allied site. LeMean is a wholly owned subsidiary of Millennium Holdings, LLC (MHLLC). MHLLC is directing the work at the site on behalf of LeMean.

groundwater at the Allied OU could impact the City's Central Well Field via groundwater migration.

The City's concern stems from a regional groundwater flow model prepared by the City that indicates that the limits of the 5-year time of travel zone of the Central Well Field potentially extends at depth beneath the Allied OU. The USEPA-approved RI Report (MDEQ 2008a) shows the capture of shallow groundwater by Portage Creek.

1.2 Site History

The Allied OU is one of four land-based OUs associated with the Kalamazoo River Superfund Site, and encompasses 89 acres along Portage Creek within the City of Kalamazoo, Michigan. The limits of the Allied OU are shown on Figure 1-1.

The Allied OU includes areas that were associated with operation of the former Bryant and Monarch Paper Mills. These mills were initially operated using virgin paper pulp to create paper products; however, starting in approximately the 1950s, the mills in the Kalamazoo area began to recycle waste paper. Carbonless copy paper produced between approximately 1957 and 1971 was included in the recycled waste paper, and was later found to contain PCBs. As a result, a portion of the paper-making residuals (residuals) associated with the Allied OU contain PCBs.

A series of remedial measures have been implemented at the Allied OU, the most significant of which was the excavation of approximately 146,000 cubic yards of PCB-containing residuals and soil from the Former Bryant Mill Pond area of Portage Creek. This work was completed as a time-critical removal action by the USEPA, and the excavated materials were placed within existing waste management areas of the property, west of Portage Creek. These disposal areas were subsequently capped. Additional interim response actions included:

- Installation of approximately 2,600 linear feet of sheet piling along the west bank of Portage Creek in 2001;

- Construction of a landfill cap, consistent with Michigan Act 451, Part 115 solid waste regulations;

- Installation of a groundwater recovery system to mitigate mounding of groundwater behind the sheet pile wall; and

- Excavation and onsite consolidation, within existing waste management areas that were subsequently capped, of additional residuals from the east side of Portage Creek and from the west side of the creek between the sheet pile wall and the creek.

A Feasibility Study (FS) is underway for the Allied OU that will evaluate various alternative remedies to address remaining concerns. The FS, which is scheduled to be submitted to the USEPA in October 2009, will incorporate data from the RI and the Supplemental Groundwater Investigation.

1.3 Existing Information

Over the past 16 years, an extensive series of investigations has been completed at the Allied OU and a large database has been developed. Tables of historical groundwater elevation data for the Allied OU and neighboring properties are included in Attachment A. An overview of information from the RI, and additional data collected following submittal of the document that can be drawn on to understand the hydrogeologic environment and the potential for transport of PCBs or inorganics in groundwater are presented below.

1.3.1 Hydrogeologic Setting

The unconsolidated materials and groundwater investigated at the Allied OU are within the surficial aquifer unit (MDEQ 2008a), which is subdivided into several transmissive zones that are separated locally by discontinuous confining layers. The lowermost of the transmissive zones of the surficial aquifer unit is identified in the RI Report as the “Lower Sand” (MDEQ 2008a). The groundwater and surface water elevation data collected prior to completion of the Supplemental Groundwater Investigation, as described in the RI Report, show that shallow groundwater discharges to Portage Creek. A series of groundwater flow maps prepared for the Allied OU consistently show groundwater contours that parallel the creek, indicating that groundwater flow is to the creek, with a northerly component of flow at the north end of the site in the vicinity of the dam. Monitoring well clusters, consisting of well groups with screens placed at different depths, have shown upward vertical gradients from the lower sand to the shallower geologic units and Portage Creek.

Two groundwater flow models completed for the Kalamazoo area (City of Kalamazoo 1999; U.S. Geological Survey [USGS] 2004) include horizontal “confining” units that extend beneath the Allied OU. A confining unit, or aquitard, is a geologic layer that limits or constrains the vertical movement of groundwater, and where laterally extensive, can hydraulically separate more transmissive strata. Cross-section B” to B’’’ (Figure 1-3), constructed from the Central Well Field through the Allied OU to the Millwood Well Field, at the location shown on Figure 1-2 shows the upper confining unit as a clayey silt, shown in green on the figure. This aquitard was not encountered during site investigations at the Allied OU because monitoring wells were not installed to the depth of the aquitard. As shown on Figure 1-3, in the area of the Central Well Field and further north toward the Kalamazoo River, one continuous unconfined sand unit is present, and the confining unit is absent. However, proceeding south, two monitoring wells south of the Central Well Field (81-10 and 81-11) indicate the presence of a thin clay unit that appears to be the northernmost extent of the confining unit (Figure 1-3). Three boring logs for wells located near the northern end of the Allied OU that were completed for environmental investigation of the neighboring Strebor property, clearly show the presence of a substantial clay unit aquitard, and the unit thickens toward the south as evidenced by the Millwood Well Field well logs. Based on the available data from supplemental information sources (MDEQ 2008b; Bay West 1991; City of Kalamazoo 1999), the continuous presence of the aquitard below the entire Allied OU can be inferred.

The presence of a continuous confining unit would limit the physical and chemical interface between the surficial aquifer and the regional aquifer in which the Central Well Field wells are installed. Further evidence indicating that groundwater from the Allied OU is not traveling toward the Central Well Field is provided by groundwater gradients. As discussed further in Section 3.3, regional data, including historical data from Strebor wells (Bay West 1991), indicate that there is an upward gradient from the regional aquifer unit to the surficial aquifer unit. The data available prior to collection of Supplemental Groundwater Investigation data suggested the presence of an aquitard between the surficial aquifer and the regional aquifer, and demonstrated the presence of upward vertical gradients. The presence of these conditions suggests that a complete migration pathway from the Allied OU to the City Central Well Field does not exist.

1.3.2 PCB Fate and Transport

Available information suggests that PCBs are not likely to impact the City's Central Well Field for the following reasons:

- PCBs are hydrophobic and do not readily dissolve in water, preferring to adhere to soil or other solids (USEPA 1979; MDEQ 2008a, 2008b). To the limited extent that PCBs do enter groundwater, travel pathways would be dictated by groundwater gradients.

- Groundwater samples from the Allied OU generally do not contain PCB concentrations above MDEQ criteria or the USEPA's Preliminary Remediation Goals (CH2M Hill 2009). Exceptions are a few instances where a well was screened in close proximity to a layer of PCB-containing residuals. Figure 1-4 illustrates the results of PCB analysis of groundwater samples collected in 2002 and 2003, following implementation of the remedial measures completed to date. As shown, out of a total of 53 locations sampled, MDEQ's Groundwater/Surface Water Interface (GSI) criterion for PCBs of 0.2 micrograms per liter (ug/L) was exceeded at three shallow monitoring points screened in direct contact with residuals. The Residential Drinking Water (RDW) criterion of 0.5 ug/L was exceeded in one split sample collected by the MDEQ (MDEQ 2004, 2008a). PCBs were detected at a concentration of 0.549 ug/L at MW-8A on October 29, 2002. The primary and duplicate samples collected by MHLLC on the same date contained PCBs at concentrations of 0.33 and 0.28 ug/L, respectively; below the RDW criterion (MDEQ 2008a).

- Prior work at the Allied OU (MDEQ 2008a) suggested that shallow groundwater discharges to Portage Creek.

- Water samples collected between October 2005 and the present from the influent of the Allied OU leachate collection system contained a detectable concentration of PCBs below both the GSI and RDW criteria on one date. A total of 38 samples were collected between October 2005 and the present, consisting of monthly samples from March 2006 through December 2008, and biannual samples from December 2008 to the present. Of these, all but one sample (97 percent) were non-detect for PCBs. The single detection was reported at the detection limit (0.1 ug/L), which is below the MDEQ's GSI criterion for PCBs. All of these samples are from water in direct contact with PCB-containing residuals, again confirming the hydrophobic nature of PCBs.

1.3.3 Inorganic Constituents in Groundwater

The RI Report indicates that certain naturally-occurring inorganic constituents (most notably iron, manganese, and arsenic) have been detected in certain shallow groundwater samples at the Allied OU at concentrations that slightly exceed (i.e., are within the same order of magnitude of) MDEQ groundwater criteria. The City of Kalamazoo has expressed concern that should there be a direct flow path for groundwater from the Allied OU to the City's Central Well Field, the public water supply might be affected by these inorganic constituents. As discussed in the following sections, the additional studies conducted for the Supplemental Groundwater Investigation were also useful in consideration of inorganic constituents in groundwater.

2. Scope of Investigation

ARCADIS evaluated various approaches and data needs required to assess the potential for a complete groundwater pathway from the Allied OU to the City's Central Well Field. Establishing an expanded hydrogeologic conceptual model, by providing additional measurement of hydraulic gradients in the vertical and horizontal directions, was selected as a direct method to assess whether the potential exists for PCBs present at the Allied OU to impact the City's Central Well Field. The primary hypotheses, which the investigation was designed to verify or disprove, are that shallow groundwater at the Allied OU discharges to Portage Creek, and that a hydraulic head differential across the low-permeability zone that underlies the Allied OU creates an upward vertical gradient, precluding potential flow to the City's Central Well Field. Synoptic measurement of water levels at available locations within and beyond the Allied OU in the direction of the City's Central Well Field was selected as the most direct and efficient way to test this hypothesis. The use of pressure transducers to collect near-continuous measurements at selected monitoring locations was considered to obtain information regarding temporal changes in groundwater flow conditions; however, due to the large amount of historical groundwater elevation data available (see Attachment A) and with the concurrence of USEPA, this method was determined to be unnecessary. Pressure transducers would have been considered in follow-up activity if the initial work suggested the need.

2.1 Identification of Potential Groundwater and Surface Water Elevation Monitoring Points

During the development of the scope of investigation for this work effort, nearby properties that have been the subject of environmental investigation were identified. The purpose of this activity was to identify existing monitoring wells near the Allied OU that could potentially provide an expanded array of groundwater monitoring points and allow for better characterization of groundwater flow patterns north and west of the Allied OU, toward the City's Central Well Field. Three properties were identified: Panelyte, Strebor, and Performance Paper. Figure 2-1 shows the locations of these neighboring properties relative to the Allied OU. Monitoring wells on each of these properties were used to obtain groundwater elevation data to provide a distribution of data points extending beyond the limits of the Allied OU.

The Strebor property is located west of the northern part of the Allied OU, and monitoring wells are present at and surrounding that property due to past environmental investigations. An active groundwater pump and treat system is also present at the Strebor property. The Panelyte property is located north of the Western Disposal Area at the Allied OU, and west of Portage Creek. Performance Paper is located north of Alcott Street, on both sides of Portage

Creek, and contains a well network previously installed during environmental investigations. Tables 2-1 and 2-2 identify the monitoring points identified for field measurement.

Of the wells identified for inclusion, three deep monitoring wells installed by Strebor that extend into the deep regional aquifer unit are of particular interest. These wells, MW-37, MW-39, and MW-40, are ideally located north and west of the Allied OU (see Figure 2-2) and each well is paired with a second well screened in the shallower, surficial aquifer unit. By comparing the relative hydraulic heads at these well cluster locations, the vertical gradient between the surficial aquifer unit that is proximal to the Allied OU residuals and the deep regional aquifer unit that is used as a drinking water source for the City, can be obtained. The remaining wells (Figure 2-2) monitored at the Allied OU, Panelyte, and Performance Paper properties are screened at various depths within the surficial aquifer unit. Additional well installations were considered but were not deemed necessary after locating appropriately positioned offsite wells. Figure 2-3 illustrates the relationship of the various monitoring well depths relative to each other and to the surficial and regional aquifer units. These units were described by the MDEQ (MDEQ 2008b) based on a review of the Groundwater Flow Model and Capture Zone Delineations prepared by the City of Kalamazoo (City of Kalamazoo 1999).

2.2 Survey Activities

To ensure that the water levels collected are referenced to a common survey datum, all of the offsite wells were surveyed between June 25 and 29, 2009 by licensed surveyors, Prein Newhof of Kalamazoo, Michigan. The top of inner casing elevations were recorded to the nearest 0.01 foot, and the ground surface elevations were established to the nearest 0.1 foot. Additional surface water level measurement locations were established at the locations shown on Figure 2-2 to provide further control on the relationship between surface water and groundwater elevations. The survey elevations are included in Tables 2-3 and 2-4.

2.3 Water Level Measurements

On June 25 and 26, 2009, water level measurements were collected at 123 monitoring wells, six staff gauge locations along Portage Creek, and one staff gauge in an area of standing water located in the southwestern part of the Allied OU. During the June 25 and 26 event, a groundwater extraction system was actively pumping at the Strebor property. A second round of measurements for a subset of 23 wells located in the vicinity of the Strebor property was conducted on July 2, 2009 during a period of shut down of the Strebor groundwater recovery system. All measurements were made using a weighted electronic water level probe per standard practices commonly accepted by USEPA and MDEQ. The collected data are summarized in Tables 2-3 and 2-4.

2.3.1 Groundwater Elevation Measurement Locations

The locations of the water level measurements are shown on Figure 2-2. All measurements were made by ARCADIS personnel, with the exception of measurements made at the Strebor wells, where as a condition of property access, Strebor's consultants collected the water level measurements under the observation of ARCADIS personnel.

2.3.2 Surface Water Elevation Measurement Locations

Due to the key role of Portage Creek in the behavior of groundwater in the study area, surface water elevation measurements were collected at the existing staff gauges and additional measurement points on existing bridge and dam abutments. In total, six points along the creek were measured. In addition, a temporary measurement point was established in a small area of standing water in the southwestern part of the Allied OU.

2.4 City of Kalamazoo Production Well Data

As part of the Supplemental Groundwater Investigation, ARCADIS also reviewed sample analytical data provided by the City for its water supply system monitoring program. The City's monitoring program has not identified PCBs in samples of groundwater collected from the Central Well Field. In 2008, samples were analyzed with analytical equipment capable of achieving detection levels well below the threshold achievable by USEPA standard methodology (USEPA 8082). Samples collected from 11 City wells in Well Fields #1 and #3 were reported to have no detections of PCBs at a detection level of 50 parts per trillion (Table 2-5), as reported in tables provided by the City of Kalamazoo via electronic mail (City of Kalamazoo 2008b). This provides direct evidence that a complete pathway does not exist for PCBs to migrate from the Allied OU to the City Central Well Field.

ARCADIS also reviewed the City's groundwater modeling results, which indicate that the Allied OU lies within a 5-year time of travel to the City's Central Well Field. PCB-containing residuals lay in an uncontrolled state for approximately 50 years subject to precipitation and natural processes, prior to the implementation of remedial actions. Given this 50-year time period, the absence of PCBs at the Central Well Field strongly suggests that a migration pathway does not exist from the Allied OU to the City's wells. Any further controls and remedial measures completed at the Allied OU following completion of the FS will further reduce any potential for migration offsite.

3. Investigation Results

Field data collection resulted in a substantial set of groundwater and surface water elevation data extending northward and westward from the Allied OU, in the direction of the City's Central Well Field. A total of 123 groundwater elevation measurements were collected; 75 from Allied OU monitoring wells and 48 from offsite locations. Surface water elevation measurements were collected at six locations along Portage Creek, and the elevation of standing water in the southwestern part of the Allied OU was also measured. The majority of the data allow for detailed characterization of the shallow surficial aquifer unit, and three monitoring well clusters provide data regarding the potential for vertical interaction between the surficial and regional aquifers in the vicinity of the Allied OU. The evaluation of the collected data is discussed in the following sections.

3.1 Groundwater Flow in the Surficial Aquifer Unit

A water table groundwater contour map, developed using the data collected on June 25 and 26, 2009, is shown on Figure 3-1. Portage Creek appears to be the primary influence on the configuration of the water table surface within the OU. In the main disposal area of the Allied OU, shallow groundwater discharges radially to Portage Creek. North of Alcott Street, the influence of Portage Creek as a location of groundwater discharge appears to be mitigated to some degree by the presence of a concrete liner, which extends from Alcott Street northward to south of Reed Avenue. In this area, shallow groundwater is influenced, although not completely captured, by the creek. There is a northerly (i.e., downstream) component of groundwater flow in this area.

Figure 3-2 shows the water table groundwater contour map with an overlay showing the approximate extent of residuals from the RI Report (MDEQ 2008a). The figure illustrates capture by Portage Creek of the shallow groundwater that could potentially be impacted by residuals at the Allied OU.

The subsurface investigation activities completed at the Allied OU, as described in the RI Report and illustrated by flow nets constructed along several cross-sections (MDEQ 2008a), have demonstrated the significant influence of vertical gradients on groundwater flow, and the potential for flow, between the various flow zones within the surficial aquifer unit. For this reason, and due to the fact that the well screen intervals of the monitored wells tend to be shallow, groundwater contour figures were not constructed at depth. Instead, the water table contour maps described above were constructed using data from wells that are screened at or near the water table surface and therefore provide comparable data points. To evaluate flow patterns at greater depth, vertical gradients were assessed, as described in Section 3.3.

Monitoring well screen depth information relative to the water table was reviewed to select data points to provide data representative of the shallow groundwater surface. The data points used to generate the water table contour figure are identified in Table 2-3.

Strebor operates several shallow groundwater recovery wells at the adjacent property northwest of the Allied OU disposal units, and to evaluate the degree of influence the pumping wells have on groundwater flow in this area, a subset of wells in this portion of the study area was gauged on July 2, 2009, following shut down of the pumping wells on July 1, 2009 for maintenance. As shown by a comparison of the central portion of Figure 3-1 (groundwater flow during operation of the Strebor wells) and Figure 3-3 (groundwater flow when the recovery system is not operating), the impact of the pumping wells on the pattern of groundwater flow is minimal. Drawdowns of 0.84 and 0.86 feet, respectively, were observed at Strebor wells MW-2 (located at the northern end of the Panelyte property) and MW-21 (located west of the Strebor property and the railroad tracks) (Figure 3-3).

The surface water elevation measurement made at the Reed Avenue bridge over Portage Creek (SG-6) was unexpectedly high, at an elevation of 763.41 feet above mean sea level (amsl). A groundwater elevation of 761.59 feet amsl was measured at the nearest shallow monitoring well, MW-14, located approximately 200 feet south on the Performance Paper property. This difference in hydraulic head suggests that surface water could locally be discharging to groundwater in this area. However, due to the distance of this area from the Allied OU (over 1400 feet from the northernmost extent of the residuals), this flow condition, if present, would not change the interpreted groundwater flow patterns at the portion of the Allied OU identified with residuals.

The data collected during this monitoring event were found to correspond well with the data presented in the RI Report, and further illustrate that pumping activities associated with the neighboring Strebor property do not change the pattern of groundwater flow within the surficial aquifer in the area. The collection of additional time series water level data was not deemed necessary due to the strength and consistency of the data.

3.2 Groundwater Flow in the Regional Aquifer Unit

Based on the groundwater modeling efforts completed by the USGS and the City (USGS 2004; City of Kalamazoo 1999), flow in the regional aquifer unit approximately 50 to 80 feet below the ground surface is to the north, toward the Kalamazoo River. Three Strebor monitoring wells included in the groundwater investigation are screened in the regional aquifer unit. The water levels measured in the three wells were above the top of the aquitard that separates the surficial and regional aquifers, indicating confined conditions in this lower zone. Due to the upward pressure exerted by the groundwater present in the regional aquifer, the downward flow of groundwater from the surficial aquifer monitored at the Allied OU to the deeper regional aquifer is highly improbable.

3.3 Vertical Flow Gradients

Two flow nets have been constructed using the June 2009 data at the locations shown on Figure 3-4. These figures depict groundwater flow in the vertical as well as the horizontal direction. The flow nets shown on Figures 3-5 and 3-6 illustrate downward gradients in the shallow fill areas (recharge areas) of the Allied OU at a distance from Portage Creek, primarily lateral flow moving toward the creek, and upward flow as the groundwater discharges to surface water.

Water elevation versus time plots for clustered wells screened at different depths were developed to assess the variation over time in vertical flow potentials between various monitored zones at specific locations. From the data collected during this groundwater investigation, three monitoring well clusters on the Allied OU property and three Strebor monitoring well clusters were selected to be depicted graphically. Figure 3-7 shows the location of the well clusters. The selection of these wells was based on spatial distribution, availability of data, and the unit of interest to be assessed.

For the Allied OU well clusters, historical data from 2006 through the present have been added to the graphs to show variations over time. Figure 3-8 illustrates data for the MW-122AR, MW-122A, MW-122B, and MW-212 monitoring well cluster. The monitoring wells in this cluster are screened at various depths within the surficial aquifer. Portage Creek water level elevations are also shown for comparison. This graph illustrates that the highest groundwater levels are observed in the upper sand, and shows a downward flow potential from the upper sand to the intermediate sand. Most importantly, the graph shows an upward gradient of approximately 0.10 feet from the lower sand unit to the intermediate sand unit. Discharge from this zone is to Portage Creek, present at the lowest elevation potential.

The graph shown on Figure 3-9 for the MW-204B, OW-2B, OW-2P, OW-2A shows a similar pattern of flow with discharge to Portage Creek at the lowest elevation; however, in this instance, the highest measured water level is in monitoring well MW-204B, which is screened in the lower sand unit of the surficial aquifer unit, indicating a strong upward gradient of approximately 0.27 feet from the lower sand unit to the upper sand unit that discharges to Portage Creek.

The third graph of data, shown on Figure 3-10, depicts data for the MW-22B, MW-10, MW-22AR, and OW-12A monitoring well cluster. In this instance, the elevation of Portage Creek is higher than the majority of measured groundwater elevations, potentially suggesting flow from or below the creek. However, this well cluster is located within approximately 25 feet of the groundwater extraction system behind the sheet pile wall. Note that the shallower wells (MW-10, MW-22AR, and OW-12A), screened in closest proximity to the recovery well points, show the most pronounced drawdown due to the influence of the groundwater removal. Importantly, the deepest well (MW-22B) generally has the highest water level, indicating an upward gradient at this location. One inconsistent measurement, collected in December 2008 at monitoring well MW-22B, shows the opposite condition; however, this data point is an anomalous outlier, varying by 3.6 feet from the average of the elevations measured from 2006 through the present at that well.

The City expressed concern that monitoring well MW-122B might be installed in the regional aquifer that is used by the City's Central Well Field, and that a downward flow gradient – as historically measured at this location relative to the shallow sand of the surficial aquifer – might direct flow of groundwater from the Allied OU to the regional aquifer. However, as shown on Figure 2-3, the screen for this well is clearly within the surficial aquifer, and well above the aquitards that separate the surficial aquifer from the lower regional aquifer. Therefore, this well will not direct flow to the regional aquifer used by the City's Central Well Field.

The City also communicated concerns that recent groundwater elevation measurements at shallow monitoring wells MW-122A and MW-122AR are conspicuously lower than measurements made historically (e.g., 2000), and that the head difference between these shallow wells and monitoring well MW-122B, screened in the lower sand unit of the surficial aquifer, is reduced from over 3 feet to a fraction of a foot. They observed that water elevation measurements at this well cluster (along with MW-122B) currently show an upward gradient where historically there was a downward gradient between the upper and lower sand units of the surficial aquifer at this location.

The differences in groundwater elevations and gradients between now and 2000 are due to this area having been covered with an impermeable cap in 2004. The MW-122-series well cluster is located in the berm immediately adjacent to Former Residuals Dewatering Lagoon (FRDL) #1, which currently and historically has been the location to which surface water runoff drains within the 22-acre Bryant HRDL/FRDLs disposal area. However, in 2000 this lagoon was unlined and any accumulated water was free to drain into the adjacent sandy berm and the shallow groundwater system, raising groundwater elevations in the immediate vicinity. In 2004, this lagoon was double-lined with an impermeable cap designed in accordance with Michigan Act 451 Part 115 solid waste regulations. As a result, surface water runoff that collects in this area is prevented from entering the groundwater system, and is discharged directly to Portage Creek. Consequently, groundwater elevations at MW-122A and MW-122AR have dropped. Note that PCBs were not detected in any groundwater samples collected from MW-122B for the RI, and inorganics were detected only at levels below MDEQ groundwater criteria, providing additional empirical evidence that groundwater does not flow downward at this location.

The monitoring well clusters at the Strebor property provide important information, as each of the three well clusters includes one well screened in the surficial aquifer unit and a second well screened in the regional aquifer unit, providing data regarding the potential for flow between the two units. Figure 3-11 illustrates the relative groundwater elevations in all three of the Strebor well clusters. At each of the three well cluster locations, there is a strong upward gradient between the regional aquifer unit and the surficial aquifer unit. For the MW-40/MW-30 well cluster, quarterly data are available for a period of 3 years, and the gradient remains consistently upward. As mentioned previously, all of the deep Strebor wells demonstrate confined conditions and one of the monitoring wells, MW-39, exhibits flowing artesian conditions. A pressure gauge was installed at the well head of MW-39 to allow for conversion of the measured pounds per square inch to feet of water. These data illustrate hydraulic disconnection between the surficial aquifer unit and the regional aquifer unit.

The results of the analysis of groundwater flow patterns, directions and gradients clearly support the RI Report conclusion that shallow groundwater at the Allied OU discharges to Portage Creek, and no additional data were obtained that suggest that there is a pathway to the regional aquifer used for the City Central Well Field. With this understanding, no further analysis was deemed necessary with respect to the distribution of inorganic constituents in onsite or offsite groundwater.

3.4 Refined Conceptual Site Model

The data collected during this investigation strongly support the Conceptual Site Model identified in the RI Report and provide a basis for a refined understanding of groundwater flow at the Allied OU and local environs. The groundwater elevation data acquired for the Supplemental Groundwater Study reflect current conditions at the Allied OU with the impermeable cap over the Bryant HRDL/FRDLs extended over the settling basin (FRDL #1), and therefore update the groundwater data, flow maps, and flow net information presented in the RI Report (MDEQ 2008). The updated data confirm that shallow groundwater within the surficial aquifer unit flows toward and discharges to Portage Creek, and that pumping at the Allied OU from behind the sheet pile has a mild influence on this flow pattern. North of Alcott

Street, the impact of the concrete-lined segment of the creek appears to mitigate the degree of capture of the shallow groundwater by the creek, and a northerly flow component is present. However, as indicated by MDEQ studies on the Performance Paper property (Malcolm Pirnie, Inc. 2004) and as shown clearly on Figure 3-2, PCB-containing residuals are not present in groundwater in this area. Overlaying the potential extent of PCBs or residuals with the groundwater flow map illustrates that Portage Creek serves as a discharge point for potentially impacted groundwater associated with the residuals at the Allied OU.

Similar to observations at the Allied OU, pumping directly from the surficial aquifer at the neighboring Strebor property has also been shown to result in minimal changes to the water table surface, and does not change the pattern of groundwater flow in the area.

The regional aquifer unit exists under confined conditions below the Allied OU, and a substantial upward gradient is present. An upward pressure gradient of 0.1 to 0.2 feet/feet exists between the regional aquifer at depth and the surficial aquifer monitored at the Allied OU mitigates the potential for the downward migration of groundwater from the surficial aquifer unit to the regional aquifer unit. The presence of confined conditions also minimizes the influence of pumping at the Central Well Field on the surficial aquifer at the Allied OU. In order to influence water levels in the surficial aquifer at the Allied OU, the upward gradient observed between the lower regional aquifer and the shallow surficial aquifer would have to be reversed. The hydraulic condition (e.g., excessive pumping) that would be required to reverse an upward gradient of 0.1 to 0.2 feet/feet between the regional and surficial aquifers over a distance of more than 2000 feet between the City's Central Well Field and the Allied OU is judged to be extremely unlikely. Differential effects of precipitation on recharging the regional and surficial aquifer systems are expected to be minimal.

3.5 Study Limitations

Although a robust data set exists for the surficial aquifer system, a limited number of wells were used to evaluate groundwater flow paths and gradients associated with the regional aquifer. If the information from these well provided ambiguous results, there might be reason to conduct further investigation into the regional aquifer conditions. However, the consistent observation of considerable upward gradients demonstrated by the well clusters in the surficial and regional aquifers over an extended period of time suggest that these conditions are likely to be laterally extensive, and representative of conditions over the long term, suggesting that no additional information is needed.

4. Findings

The Supplemental Groundwater Investigation, together with prior data, provides a basis to conclude that a groundwater pathway is not present from the Allied OU to the City Central Well Field. The key findings are summarized below, followed by a discussion of other relevant information that collectively reduce any remaining uncertainty in this conclusion.

- Groundwater table contour maps constructed for the water table show that gradients in the shallow aquifer are directed toward Portage Creek and are in an easterly, onsite direction along the western boundary of the Allied OU, with a northerly component of flow at the north end of the site near the dam (see Figure 3-1).

- The groundwater contour maps together with vertical flow nets (See Figures 3-1, and 3-3 through 3-6) indicate that Portage Creek is the discharge point for shallow groundwater at the Allied OU.

- Vertical gradients measured at three monitoring well clusters at the Allied OU screened at different depth intervals within the surficial aquifer show strong upward gradients relative to Portage Creek, and strong upward gradients from the lower sand to the shallow intermediate sand unit within the surficial aquifer. Monitoring wells at the Allied OU do not extend into the regional aquifer present at depth.

- Data for three shallow and deep well pairs previously installed by Strebor provide groundwater elevation data for both the surficial aquifer and the deeper regional aquifer, and indicate a strong upward gradient (i.e., upward flow potential) from the regional aquifer to the surficial aquifer.

These findings indicate that a groundwater flow pathway for PCBs and inorganics at the Allied OU to the City's Central Well Field is not present because: a) shallow groundwater flows to the east toward Portage Creek and not in a northwesterly offsite direction, and b) the flow potential between the deeper regional aquifer and the shallower surface aquifer is directed upward. If there is flow between these two units at the Allied OU, the available data indicate it would be upward into the shallow aquifer, with subsequent discharge to Portage Creek.

Although these findings demonstrate that the local hydrogeology indicates that groundwater at the Allied OU does not pose a threat to the City's Central Well Field, further confidence in this conclusion is lent through a review of PCB fate and transport considerations and other available information, as summarized below.

- PCBs are hydrophobic (meaning they do not readily dissolve in water and preferentially attach to soil particles) and as a result, are typically present in only very low concentrations in groundwater, especially groundwater not in immediate contact with PCB-containing materials. As a result, PCBs are not typically detected in any significant quantity in wells that are screened outside of the limits of PCB-containing residuals.

- Generally speaking, PCBs have not been observed in groundwater at levels above criteria away from the Allied OU, and detections above MDEQ criteria are observed only in the immediate vicinity of or in contact with residuals.

- The low hydraulic conductivity of residuals is also an important factor in the limited mobility of PCBs. Groundwater does not readily pass through these clay-like materials.

- The groundwater collection and treatment system currently operating at the Allied OU collects groundwater from the downgradient perimeter of the Bryant HRDL/FRDLs area. Of 38 samples of the influent to the treatment system that were collected over the period from March 2006 to present, only one sample contained a detectable concentration of PCBs. The detection was reported at the detection limit of 0.1 ug/L, which is below MDEQ's GSI criterion. No PCBs were detected in the other 37 (97 percent of samples).

- Two groundwater flow models completed for the Kalamazoo area (City of Kalamazoo 1999; USGS 2004) identify and simulate horizontal "confining" units that extend beneath the Allied OU. The confining unit that separates the surficial aquifer system monitored at the Allied OU and the regional aquifer system tapped by the City Central Well Field was encountered in the vicinity of the northern portion of the Allied OU in monitoring wells installed at the neighboring Strebor property. This confining layer is partially responsible for the upward pressure of the deeper regional aquifer into the overlying surficial aquifer, and its presence tends to limit communication of groundwater between these two aquifers.

- Routine monitoring data collected by the City of Kalamazoo from the Central Well Field show that PCBs have not been detected. Recent tests using lower detection limits confirm historical findings that PCBs are not present. Conditions at the Allied OU are not conducive to migration of groundwater from the Allied OU toward the City Central Well Field, and it is reasonable to conclude that they do not pose a threat to the City's well supply.

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Tables

Table 2-1 -- Allied OU - Monitoring Well Construction Data

Well/ Piezometer	Date Installed	Aquifer Unit	Total Depth of Monitoring Well (feet bgs)	Top of Casing Elevation (feet AMSL)	Ground Surface Elevation (feet AMSL)	Elevation of Bottom of Screen (feet AMSL)	Elevation of Top of Screen (feet AMSL)	Elevation of Mid Point of Screen (feet AMSL)	Elevation of Top of Filter Pack (feet AMSL)	Elevation of Top of Bentonite (feet AMSL)	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)
FW-101	6/10/2002	Surficial	5.0	800.36	797.3	793.1	795.3	794.2	796.3	797.3	Upper Sand
GWE-1	2/10/2000	Surficial	25.5	803.21	802.7	782.0	791.8	786.9	794.8	796.8	Upper Sand/Peat/Upper Aquitard
GWE-1A	5/4/2000	Surficial	35.0	806.07	806.6	776.8	791.7	784.2	792.8	795.6	Upper Sand/Upper Aquitard
GWE-1P	2/10/2000	Surficial	NA	803.03	NA	NA	NA	NA	NA	NA	NA
GWE-4A	6/20/2000	Surficial	34.4	805.27	805.7	771.3	781.2	776.3	784.2	801.7	Upper Sand
MW-5R	3/26/1998	Surficial	26.1	811.87	810.1	783.6	789.6	786.6	789.6	792.1	Peat/Upper Sand
MW-6	11/16/1985	Surficial	25.0	812.70	810.7	785.7	788.7	787.2	790.7	809.7	Upper Sand
MW-7	11/16/1985	Surficial	31.0	818.94	817.4	786.4	789.4	787.9	791.4	816.4	Upper Sand
MW-8A	8/10/1993	Surficial	18.0	810.74	809.0	791.0	796.0	793.5	796.0	799.0	Peat/Upper Sand/Upper Aquitard
MW-22AR	4/1/1998	Surficial	16.5	805.79	807.5	791.0	796.0	793.5	796.5	798.5	Upper Sand/Peat
MW-22B	8/11/1993	Surficial	48.0	809.25	804.6	757.6	762.6	760.1	764.6	767.6	Intermediate/Lower Sand[2]
MW-23R	10/19/2000	Surficial	25.0	809.33	804.0	779.0	784.0	781.5	786.0	793.0	Sand[3]
MW-24R	3/27/1998	Surficial	24.0	803.37	806.6	782.6	787.6	785.1	788.6	791.1	Upper Sand/Upper Aquitard
MW-26	8/25/1989	Surficial	9.0	792.10	790.0	781.0	784.0	782.5	784.0	789.0	Upper Sand
MW-120A	7/28/1993	Surficial	23.5	822.21	819.6	796.1	801.1	798.6	801.4	804.6	Residuals/Upper Sand
MW-120B	7/27/1993	Surficial	30.5	821.85	819.4	788.9	793.9	791.4	793.9	796.9	Upper Sand
MW-122A	8/6/1993	Surficial	21.5	806.45	803.4	781.9	791.9	786.9	794.0	797.4	Upper Sand/Peat
MW-122AR	3/31/1998	Surficial	19.3	807.25	804.0	784.7	794.7	789.7	795.9	800.0	Upper Sand/Peat
MW-122B	8/4/1993	Surficial	60.3	806.58	803.6	743.3	748.3	745.8	750.4	753.6	Lower Sand
MW-124A	8/23/1993	Surficial	36.0	843.74	841.3	805.3	815.3	810.3	817.3	820.3	Upper Sand
MW-124B	8/19/1993	Surficial	59.0	844.43	842.1	783.1	788.1	785.6	790.1	793.6	Upper Sand
MW-125A	8/22/1993	Surficial	25.0	810.05	807.7	783.2	788.2	785.7	788.3	791.3	Upper Sand/Peat
MW-126A	7/21/1993	Surficial	20.5	805.68	802.8	782.3	787.3	784.8	787.3	790.3	Upper Sand
MW-126AR	4/1/1998	Surficial	21.5	805.12	803.6	782.1	787.1	784.6	787.8	790.6	Upper Sand
MW-16B	6/13/1988	Surficial	33.0	803.26	801.9	768.9	771.9	770.4	773.9	800.9	Intermediate Sand
MW-19BR	8/20/1993	Surficial	39.0	822.06	819.5	780.5	785.5	783.0	787.5	790.3	Upper Aquitard[4]
MW-200A	10/4/2000	Surficial	15.8	803.73	800.9	785.1	790.1	787.6	791.9	793.9	Sand[3]
MW-201B	10/5/2000	Surficial	28.0	802.20	800.3	772.3	777.3	774.8	779.3	783.3	Sand[3]
MW-202B	9/24/2000	Surficial	35.0	803.73	801.1	767.9	772.6	770.3	774.6	778.1	Sand[3]
MW-203B	9/23/2000	Surficial	23.7	801.97	798.3	774.7	779.4	777.0	781.0	792.3	Sand[3]
MW-204B	10/9/2000	Surficial	84.0	807.05	800.6	716.6	721.6	719.1	727.0	745.6	Lower Sand
MW-205B	10/11/2000	Surficial	64.0	805.72	799.5	735.5	740.5	738.0	742.5	797.5	Lower Sand
MW-206A	6/10/2002	Surficial	12.0	800.85	797.7	785.7	790.7	788.2	791.2	795.7	Sand[3]
MW-207	5/31/2002	Surficial	33.0	805.00	797.9	765.3	769.9	767.6	771.9	774.9	Intermediate/Lower Sand[2]
MW-208	5/30/2002	Surficial	23.0	804.42	796.3	773.3	778.3	775.8	780.3	783.8	Intermediate/Lower Sand[2]
MW-209	6/17/2002	Surficial	33.0	792.40	787.0	754.0	759.0	756.5	761.0	764.0	Intermediate Sand

See Notes on Page 3

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table 2-1 -- Allied OU - Monitoring Well Construction Data

Well/ Piezometer	Date Installed	Aquifer Unit	Total Depth of Monitoring Well (feet bgs)	Top of Casing Elevation (feet AMSL)	Ground Surface Elevation (feet AMSL)	Elevation of Bottom of Screen (feet AMSL)	Elevation of Top of Screen (feet AMSL)	Elevation of Mid Point of Screen (feet AMSL)	Elevation of Top of Filter Pack (feet AMSL)	Elevation of Top of Bentonite (feet AMSL)	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)
MW-210	6/5/2002	Surficial	18.1	806.55	797.0	779.0	784.0	781.5	785.0	789.0	Sand[3]
MW-211	6/17/2002	Surficial	28.6	793.15	788.1	759.9	764.6	762.3	766.6	769.6	Intermediate Sand
MW-212	6/18/2002	Surficial	17.3	791.52	786.8	769.9	774.6	772.3	776.8	780.8	Intermediate Sand
MW-213	7/3/2002	Surficial	21.0	791.73	787.4	766.8	771.4	769.1	773.4	776.4	Intermediate Sand
MW-214	7/8/2002	Surficial	30.0	803.66	794.2	764.6	769.2	766.9	770.2	772.3	Upper Aquitard/Intermediate Sand
MW-215	3/31/2003	Surficial	6.0	790.56	783.6	777.8	782.6	780.2	783.1	784.6	Upper Sand
MW-216	3/28/2003	Surficial	9.6	790.54	783.6	774.2	779.0	776.6	779.5	781.6	Upper Sand
MW-217	3/28/2003	Surficial	9.6	790.79	783.2	774.7	776.7	775.7	777.2	780.2	Peat/Upper Sand
MW-218	3/28/2003	Surficial	12.0	790.73	783.5	771.7	776.5	774.1	777.0	780.5	Upper Sand
MW-219	3/28/2003	Surficial	13.5	790.97	788.9	775.6	780.4	778.0	780.9	784.9	Upper Sand
MW-220	3/31/2003	Surficial	6.0	790.81	785.9	780.1	784.9	782.5	785.4	786.9	Upper Sand
MW-221R	4/8/2003	Surficial	8.0	791.11	785.9	778.0	779.9	778.9	780.4	783.9	Upper Sand
MW-222	4/3/2003	Surficial	10.0	797.32	792.8	783.2	787.8	785.5	788.3	791.8	Peat/Upper Sand
MW-223	4/3/2003	Surficial	9.0	797.91	794.3	785.3	788.2	786.8	793.6	795.3	Upper Sand
MW-224	3/12/2003	Surficial	24.0	813.28	810.3	786.7	791.3	789.0	793.3	796.7	Upper Sand
MW-225	3/7/2003	Surficial	9.5	792.94	789.4	780.3	784.9	782.6	785.4	787.9	Upper Sand
MW-226	3/3/2003	Surficial	2.0	790.67	783.8	781.8	783.8	782.8	783.9	784.8	Upper Sand
MW-227	3/28/2003	Surficial	2.0	790.66	782.1	780.1	782.1	781.1	782.2	783.1	Upper Sand
MW-228	3/28/2003	Surficial	3.0	790.98	783.4	780.4	783.4	781.9	783.5	784.4	Upper Sand
MW-229	3/28/2003	Surficial	4.0	791.33	784.3	780.3	784.3	782.3	784.4	785.3	Upper Sand
MW-230	4/3/2003	Surficial	4.0	790.88	785.9	781.9	785.9	783.9	786.0	786.9	Upper Sand
MW-231	3/31/2003	Surficial	22.0	790.66	785.9	764.1	768.9	766.5	770.1	772.6	Intermediate Sand
MW-232	3/31/2003	Surficial	12.0	790.64	785.3	773.3	776.3	774.8	777.0	781.3	Upper Sand
OW-1A	2/17/2000	Surficial	20.5	803.08	806.7	786.3	788.3	787.3	788.8	792.2	Upper Sand
OW-1P	2/21/2000	Surficial	14.9	803.43	803.6	788.8	797.8	793.3	798.6	801.6	Upper Sand
OW-2A	2/22/2000	Surficial	18.5	804.01	804.6	786.2	788.1	787.2	788.5	791.6	Upper Sand/Upper Aquitard
OW-2B	2/21/2000	Surficial	34.4	803.80	804.4	770.4	775.2	772.8	776.9	780.2	Intermediate Sand/Lower Aquitard
OW-2P	2/22/2000	Surficial	15.5	804.21	804.7	789.3	794.1	791.7	795.2	797.9	Upper Sand
OW-3AR	9/28/2000	Surficial	15.0	803.91	799.1	784.1	788.7	786.4	790.1	792.1	Upper Sand
OW-3PR	9/28/2000	Surficial	8.4	807.21	798.9	790.9	795.7	793.3	796.6	797.9	Upper Sand/Peat
OW-4AR	9/27/2000	Surficial	25.0	809.41	804.2	779.2	783.8	781.5	785.2	786.7	Sand[3]
OW-4PR	6/25/2002	Surficial	8.4	811.26	801.4	793.0	800.5	796.8	800.5	801.4	Upper Sand
OW-5P	3/2/2000	Surficial	21.4	816.52	817.4	796.1	800.9	798.5	802.8	805.4	Upper Sand
OW-6A	3/3/2000	Surficial	31.9	817.32	818.2	786.3	791.1	788.7	792.4	794.7	Sand[3]
OW-6P	3/7/2000	Surficial	21.5	817.40	818.2	796.8	801.6	799.2	803.8	805.9	Residuals/Upper Sand

See Notes on Page 3

Table 2-1 -- Allied OU - Monitoring Well Construction Data

Well/ Piezometer	Date Installed	Aquifer Unit	Total Depth of Monitoring Well (feet bgs)	Top of Casing Elevation (feet AMSL)	Ground Surface Elevation (feet AMSL)	Elevation of Bottom of Screen (feet AMSL)	Elevation of Top of Screen (feet AMSL)	Elevation of Mid Point of Screen (feet AMSL)	Elevation of Top of Filter Pack (feet AMSL)	Elevation of Top of Bentonite (feet AMSL)	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)
OW-7PR	6/14/2000	Surficial	16.8	806.02	805.9	789.4	794.2	791.8	794.9	796.9	Upper Sand
OW-9PR	9/26/2000	Surficial	10.0	811.50	801.1	791.1	796.1	793.6	798.1	799.6	Upper Sand/Peat
OW-11A	10/7/2000	Surficial	18.5	804.01	799.4	781.2	785.9	783.6	787.9	789.9	Upper Sand
OW-12A	9/1/2000	Surficial	24.4	807.73	803.9	779.7	784.4	782.0	785.9	802.9 [1]	Upper Sand
OW-13A	10/3/2000	Surficial	14.8	800.77	798.0	783.4	786.2	784.8	787.0	788.5	Upper Sand
OW-14P	5/31/2002	Surficial	8.0	804.16	795.8	788.0	792.8	790.4	793.3	795.8	Upper Sand/Upper Aquitard
OW-15P	6/26/2002	Surficial	16.7	813.78	809.3	792.7	797.6	795.1	799.6	802.1	Upper Sand
OW-16P	6/26/2002	Surficial	7.1	806.06	797.7	790.7	795.6	793.1	796.7	797.7	Upper Sand
OW-17P	6/26/2002	Surficial	6.5	803.56	794.0	787.6	792.5	790.0	793.0	794.0	Upper Sand

Notes:

[1] Depth to top of grout; bentonite not present.

[2] The hydrostratigraphic unit screened is identified as lower sand or intermediate/lower sand; however, note that these unit descriptions refer to the lower portion of the *surficial* aquifer.

[3] Intervening clay layers are absent beneath the peat in this area of the Allied OU; therefore, the upper, intermediate and lower sand units can be thought of as one hydrostratigraphic unit within the surficial unit.

[4] Screens a sand seam within the upper aquitard.

RI = Remedial Investigation.
bgs = below ground surface.
AMSL = above mean sea level.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
TOC = Top of casing
Aquifer Unit designations are based on aquifer descriptions in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.
Well construction data from 2008 Remedial Investigation Report (CDM, 2008), total depth of monitoring wells was added based on well construction logs.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table 2-2 -- Neighboring Properties - Monitoring Well Construction Data

Well Number	Boring Log Available	Date Installed	Top of Casing Elevation (feet AMSL)[1]	Ground Elevation (feet AMSL)[1]	Screened Interval (feet bgs)	Top of Screen (feet AMSL)[1]	Bottom of Screen (feet AMSL)[1]	Aquifer Unit
Strebor Property								
MW-1	No	NA	802.79	801.2	11 - 16	790.2	785.2	Surficial
MW-7	No	NA	795.28	793.2	7 - 12	786.2	781.2	Surficial
MW-15	No	NA	797.23	796.2	5.5 - 10.5	790.7	785.7	Surficial
MW-21	No	NA	794.63	792.8	5 - 10	787.8	782.8	Surficial
MW-24	Yes	9/1/1987	799.97	797.6	5.3 - 13.1	792.3	784.5	Surficial
MW-25	Yes	9/7/1987	795.04	792.9	22.3 - 27.1	775.3	765.8	Surficial
MW-30	Yes	11/5/1987	796.32	793.8	9.7 - 14.7	784.1	779.1	Surficial
MW-35	Yes	11/13/1988	794.88	792.0	15.3 - 20.3	776.7	771.7	Surficial
MW-36	Yes	9/17/1990	788.55	785.7	2 - 12	783.7	773.7	Surficial
MW-37	Yes	9/18/1990	788.28	785.9	82 - 87	703.9	698.9	Regional
MW-38	Yes	9/19/1990	781.50	779.2	2.2 - 12.2	777.0	767.0	Surficial
MW-39	Yes	9/20/1990	781.55	778.9	80.5 - 85.5	698.4	693.4	Regional
MW-40	Yes	9/2/1990	796.51	794.1	87 - 92	707.1	702.1	Regional
Panelyte Property								
MW1	Yes	5/23/2002	797.16	794.6	7 - 17	787.6	777.6	Surficial
MW2	Yes	5/22/2002	795.98	793.6	5 - 15	788.6	778.6	Surficial
MW3	Yes	5/22/2002	799.44	797.0	6 - 16	791.0	781.0	Surficial
MW4	Yes	5/23/2002	795.33	793.0	4 - 14	789.0	779.0	Surficial
MW5	Yes	5/24/2002	795.05	792.5	2 - 12	790.5	780.5	Surficial
MW6	Yes	5/28/2002	792.70	795.0	4 - 14	791.0	781.0	Surficial
MW7	Yes	5/28/2002	795.40	793.3	4 - 14	789.3	779.3	Surficial
MW8	Yes	5/21/2002	795.90	793.3	6 - 16	787.3	777.3	Surficial
MW9	Yes	5/20/2002	781.11	778.9	1 - 3.5	777.9	775.4	Surficial
MW10	Yes	5/20/2002	781.56	779.1	4 - 5.7	775.1	773.4	Surficial
MW11	Yes	5/20/2002	782.95	780.8	3 - 5.5	777.8	775.3	Surficial
Performance Paper Property								
ATL-03	Yes	8/11/1990	777.38	773.6	10.2 - 15.2	763.4	758.4	Surficial
ATL-04	Yes	8/11/1990	780.27	777.6	19.7 - 24.7	757.9	752.9	Surficial
ATL-05	Yes	8/11/1990	773.42	769.9	9.6 - 14.6	760.3	755.3	Surficial
MW2-02	No	NA	783.40	781.0	13.1 - 18.1	767.9	762.9	Surficial
MW-3	No	NA	NA	NA	5 - 15	NA	NA	Surficial
MW3-01	No	NA	777.44	775.3	22 - 27	753.3	748.3	Surficial
MW3-02	No	NA	777.81	775.6	8.7 - 13.7	766.9	761.9	Surficial
MW3-04	No	NA	776.07	776.2	17.7 - 22.7	758.5	753.5	Surficial
MW-4	No	NA	NA	NA	15 - 25	NA	NA	Surficial
MW-5	No	NA	NA	NA	5 - 15	NA	NA	Surficial
MW-6	No	NA	780.27	777.7	13 - 23	764.7	754.7	Surficial
MW-7	No	NA	783.72	780.8	15 - 25	765.8	755.8	Surficial
MW-9	No	NA	787.64	784.8	15.4 - 20.4	769.4	764.4	Surficial
MW-10D	No	NA	781.52	778.5	33.6 - 38.6	744.9	739.9	Surficial
MW-10S	No	NA	780.73	778.1	10.9 - 15.9	767.2	762.2	Surficial

See Notes on Page 2.

Table 2-2 -- Neighboring Properties - Monitoring Well Construction Data

Well Number	Boring Log Available	Date Installed	Top of Casing Elevation (feet AMSL)[1]	Ground Elevation (feet AMSL)[1]	Screened Interval (feet bgs)	Top of Screen (feet AMSL)[1]	Bottom of Screen (feet AMSL)[1]	Aquifer Unit
Performance Paper Property (Cont.)								
MW-11	No	NA	778.96	776.1	8.3 - 13.3	767.8	762.8	Surficial
MW-12D	No	NA	771.65	768.8	28.7 - 33.7	740.1	735.1	Surficial
MW-12S	No	NA	771.41	768.6	6.4 - 11.4	762.2	757.2	Surficial
MW-13	No	NA	788.40	785.5	19.6 - 24.6	765.9	760.9	Surficial
MW-14	No	NA	767.76	764.5	3.2 - 8.2	761.3	756.3	Surficial
MW-15D	No	NA	779.79	777.1	35.8 - 40.8	741.3	736.3	Surficial
MW-15S	No	NA	779.72	777.2	15.1 - 20.1	762.1	757.1	Surficial
MW-16D	No	NA	777.36	774.5	31.5 - 36.5	743.0	738.0	Surficial
MW-16S	No	NA	776.94	774.5	12.3 - 17.3	762.2	757.2	Surficial
MWB-02	No	NA	783.25	780.5	17.3 - 22.3	763.2	758.2	Surficial
MWB-03	No	NA	NA	NA	20.4 - 25.4	NA	NA	Surficial
MWLTI	No	NA	NA	NA	16.3 - 21.3	NA	NA	Surficial
PW-1	No	NA	789.47	786.4	34.7 - 39.7	751.7	746.7	Surficial
PW-2	No	NA	786.18	783.0	22.1 - 27.1	760.9	755.9	Surficial
PW-3	No	NA	778.22	774.3	11.6 - 16.6	762.8	757.8	Surficial
PW-4	No	NA	775.63	772.6	12.6 - 17.6	760.0	755.0	Surficial
PW-5	No	NA	775.04	772.1	21.6 - 26.6	750.4	745.4	Surficial
PW-6	No	NA	774.24	771.0	24.2 - 29.2	746.9	741.9	Surficial

Notes:
bgs = below ground surface.
AMSL = above mean sea level.
NA = not available.
TOC = Top of casing.
[1] Surveyed by Prein & Newhof in 2009.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
Aquifer Unit designations are based on aquifer descriptions in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.
Well Construction information for Performance Paper Property from Impacted Materials Assessment and Portage Creek Channel Restoration Summary Report for Performance Paper Site 315, 405, 505 E. Alcott Street Kalamazoo, Michigan 49001 URS, June 2006.
Well construction information for the Strebor Property from the Remedial Investigation and Feasibility Study for Strebor Inc., Kalamazoo, Inc., by Bay West, Inc., dated 7/24/1991.
Well construction information for Panelyte Site wells is from the Preliminary Site Assessment Report, Former Panelyte Site, Kalamazoo Michigan, Malcolm Pirnie, December 8, 2004.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table 2-3 -- Allied OU and Neighboring Properties - June 25-26, 2009 Groundwater and Surface Water Elevation Data

Well/ Piezometer	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)	Top of Casing Elevation (feet AMSL)	6/25-6/26/09 Depth to Water (ft below TOC)	Measured Depth to Bottom (ft below TOC)	Groundwater Elevation (feet AMSL)	Locations Used for Water Table Contour Map
Allied OU						
FW-101	Upper Sand	800.36	4.66	7.51	795.70	X
GWE-1	Upper Sand/Peat/Upper Aquitard	803.21	19.95	24.90	783.26	
GWE-1A	Upper Sand/Upper Aquitard	806.07	18.12	NA	787.95	X
GWE-1P	NA	803.03	5.50	5.51	797.53	
GWE-4A	Upper Sand	805.27	22.65	40.91	782.62	
MW-5R	Peat/Upper Sand	811.87	18.77	28.09	793.10	
MW-6	Upper Sand	812.70	14.09	28.02	798.61	X
MW-7	Upper Sand	818.94	18.64	33.15	800.30	X
MW-8A	Peat/Upper Sand/Upper Aquitard	810.74	11.20	20.31	799.54	X
MW-22AR	Upper Sand/Peat	805.79	17.21	19.06	788.58	X
MW-22B	Intermediate/Lower Sand[1]	809.25	16.87	51.81	792.38	
MW-23R	Sand[2]	809.33	15.68	32.34	793.65	
MW-24R	Upper Sand/Upper Aquitard	803.37		Obstruction		
MW-26	Upper Sand	792.10	4.52	11.35	787.58	
MW-120A	Residuals/Upper Sand	822.21	21.15	26.34	801.06	X
MW-120B	Upper Sand	821.85	22.79	33.20	799.06	
MW-122A	Upper Sand/Peat	806.45	15.63	22.60	790.82	
MW-122AR	Upper Sand/Peat	807.25	15.87	16.70	791.38	X
MW-122B	Lower Sand	806.58	15.55	61.39	791.03	
MW-124A	Upper Sand	843.74	29.12	39.23	814.62	X
MW-124B	Upper Sand	844.43	40.75	61.34	803.68	
MW-125A	Upper Sand/Peat	810.05	16.99	27.14	793.06	X
MW-126A	Upper Sand	805.68	10.11	23.60	795.57	
MW-126AR	Upper Sand	805.12	11.03	23.45	794.09	X
MW-16B	Intermediate Sand	803.26	15.65	35.40	787.61	
MW-19BR	Upper Aquitard[3]	822.06	24.57	39.90	797.49	
MW-200A	Sand[3]	803.73	8.21	18.55	795.52	
MW-201B	Sand[3]	802.20	6.31	30.94	795.89	
MW-202B	Sand[3]	803.73	11.54	40.10	792.19	
MW-203B	Sand[3]	801.97	11.59	31.85	790.38	
MW-204B	Lower Sand	807.05	1.19	93.00	805.86	
MW-205B	Lower Sand	805.72	12.02	71.00	793.70	
MW-206A	Sand[3]	800.85	4.60	15.24	796.25	
MW-207	Intermediate/Lower Sand[1]	805.00	10.10	40.15	794.90	
MW-208	Intermediate/Lower Sand[1]	804.42	13.72	31.08	790.70	
MW-209	Intermediate Sand	792.40	0.00[4]	32.55	NA	
MW-210	Sand[2]	806.55	12.16	27.31	794.39	
MW-211	Intermediate Sand	793.15	1.41	33.53	791.74	
MW-212	Intermediate Sand	791.52	3.21	22.16	788.31	
MW-213	Intermediate Sand	791.73	0.20	25.08	791.53	
MW-214	Upper Aquitard/Intermediate Sand	803.66	16.03	40.06	787.63	
MW-215	Upper Sand	790.56	7.90	12.95	782.66	X
MW-216	Upper Sand	790.54	8.35	16.47	782.19	
MW-217	Peat/Upper Sand	790.79	7.88	17.53	782.91	
MW-218	Upper Sand	790.73	5.02	19.44	785.71	
MW-219	Upper Sand	790.97	6.48	20.41	784.49	
MW-220	Upper Sand	790.81	6.66	10.91	784.15	X
MW-221R	Upper Sand	791.11	9.03	13.31	782.08	
MW-222	Peat/Upper Sand	797.32	3.78	14.41	793.54	
MW-223	Upper Sand	797.91	5.16	9.65	792.75	X
MW-224	Upper Sand	813.28	22.39	27.00	790.89	X
MW-225	Upper Sand	792.94	5.60	12.59	787.34	
MW-226	Upper Sand	790.67	7.21	9.05	783.46	X
MW-227	Upper Sand	790.66	9.11	10.06	781.55	X
MW-228	Upper Sand	790.98	8.07	10.55	782.91	X
MW-229	Upper Sand	791.33	8.09	8.68	783.24	X
MW-230	Upper Sand	790.88	5.76	9.03	785.12	X

See Notes on Page 3.

Table 2-3 -- Allied OU and Neighboring Properties - June 25-26, 2009 Groundwater and Surface Water Elevation Data

Well/ Piezometer	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)	Top of Casing Elevation (feet AMSL)	6/25-6/26/09 Depth to Water (ft below TOC)	Measured Depth to Bottom (ft below TOC)	Groundwater Elevation (feet AMSL)	Locations Used for Water Table Contour Map
Allied OU (Cont.)						
MW-231	Intermediate Sand	790.66	3.98	28.98	786.68	
MW-232	Upper Sand	790.64	7.48	17.55	783.16	
OW-1A	Upper Sand	803.08	17.10	24.47	785.98	
OW-1P	Upper Sand	Not Located				
OW-2A	Upper Sand/Upper Aquitard	804.01	16.83	20.63	787.18	
OW-2B	Intermediate Sand/Lower Aquitard	803.80	14.04	36.30	789.76	
OW-2P	Upper Sand	804.21	17.15	17.69	787.06	X
OW-3AR	Upper Sand	803.91	16.19	22.13	787.72	
OW-3PR	Upper Sand/Peat	807.21	Dry/Damaged	16.00	NA	
OW-4AR	Sand[2]	809.41	Dry/Damaged	17.76	NA	
OW-4PR	Upper Sand	811.26	14.12	18.63	797.14	X
OW-5P	Upper Sand	816.52	Dry/Damaged	NA	NA	
OW-6A	Sand[2]	817.32	20.90	34.58	796.42	
OW-6P	Residuals/Upper Sand	817.40	18.11	23.96	799.29	X
OW-7PR	Upper Sand	806.02	16.26	19.58	789.76	
OW-9PR	Upper Sand/Peat	811.50	18.85	20.55	792.65	X
OW-11A	Upper Sand	804.01	15.03	22.53	788.98	
OW-12A	Upper Sand	807.73	20.39	32.28	787.34	
OW-13A	Upper Sand	800.77	14.85	21.84	785.92	
OW-14P	Upper Sand/Upper Aquitard	804.16	13.90	16.55	790.26	X
OW-15P	Upper Sand	813.78	17.49	20.40	796.29	X
OW-16P	Upper Sand	806.06	13.41	15.52	792.65	X
OW-17P	Upper Sand	803.56	14.18	16.08	789.38	X
Panelyte Property						
MW1	NA	797.16	8.10	20.04	789.06	X
MW2	NA	795.98	8.85	9.25	787.13	X
[2] The hydrostratigraphic unit screened is identified as lower sand or intermediate/lower sand; however, borings in this area of the Allied OU have not extended to a sufficient depth to locate	NA	799.44	5.25	16.55	794.19	X
MW4	NA	795.33	6.12	16.99	789.21	X
MW5	NA	795.05	6.61	14.90	788.44	X
MW6	NA	792.70	6.63	6.91	786.07	X
MW7	NA	795.40	8.15	9.00	787.25	X
MW8	NA	795.90	5.76	18.82	790.14	X
MW9	NA	781.11	2.39	5.75	778.72	X
MW10	NA	781.56	Damaged			
MW11	NA	782.95	1.95	8.05	781.00	X
Strebor Property						
MW-1	NA	802.79	10.46	NA	792.33	X
MW-7	NA	795.28	8.14	NA	787.14	X
MW-15	NA	797.23	9.11	NA	788.12	X
MW-21	NA	794.63	8.94	NA	785.69	X
MW-24	NA	799.97	9.61	NA	790.36	X
MW-25	NA	795.04	7.94	NA	787.10	
MW-30	NA	796.32	13	NA	783.32	X
MW-35	NA	794.88	9.05	NA	785.83	
MW-36	NA	788.55	9.59	NA	778.96	X
MW-37	NA	788.28	4.93	NA	783.35	
MW-38	NA	781.50	7.73	NA	773.77	X
MW-39	NA	781.55	8.09*	NA	789.64	
MW-40	NA	796.51	5.74	NA	790.77	
Performance Paper Property						
ATL-03	NA	777.38	10.10	18.96	767.28	X
ATL-04	NA	780.27	18.95	27.56	761.32	
ATL-05	NA	773.42	8.93	18.15	764.49	X
MW2-02	NA	783.40	17.02	20.65	766.38	X
MW-3	NA	NA	Not Located			
MW3-01	NA	777.44	13.23	29.06	764.21	

See Notes on Page 3.

Table 2-3 -- Allied OU and Neighboring Properties - June 25-26, 2009 Groundwater and Surface Water Elevation Data

Well/ Piezometer	Hydrostratigraphic Unit Screened Within Surficial Aquifer Unit (Units as Defined in RI)	Top of Casing Elevation (feet AMSL)	6/25-6/26/09			Locations Used for Water Table Contour Map
			Depth to Water (ft below TOC)	Measured Depth to Bottom (ft below TOC)	Groundwater Elevation (feet AMSL)	
Performance Paper Property (Cont.)						
MW3-02	NA	777.81	13.66	16.10	764.15	X
MW3-04	NA	776.07	11.82	14.43	764.25	X
MW-4	NA	NA	Not Located			
MW-5	NA	NA	Not Located			
MW-6	NA	780.27	14.09	28.02	766.18	X
MW-7	NA	783.72	21.72	28.19	762.00	X
MW-9	NA	787.64	16.59	23.46	771.05	
MW-10D	NA	781.52	11.65	41.70	769.87	
MW-10S	NA	780.73	13.38	18.40	767.35	X
MW-11	NA	778.96	7.45	16.23	771.51	X
MW-12D	NA	771.65	4.45	36.55	767.20	
MW-12S	NA	771.41	5.18	14.20	766.23	X
MW-13	NA	788.40	21.67	27.68	766.73	
MW-14	NA	767.76	6.17	11.67	761.59	X
MW-15D	NA	779.79	16.98	43.65	762.81	
MW-15S	NA	779.72	17.45	22.75	762.27	X
MW-16D	NA	777.36	15.50	39.57	761.86	
MW-16S	NA	776.94	15.10	19.98	761.84	X
MWB-02	NA	783.25	21.09	25.02	762.16	
MWB-03	NA	NA	Not Located			
MWLTI	NA	NA	Not Located			
PW-1	NA	789.47	21.02	41.03	768.45	
PW-2	NA	786.18	Damaged			
PW-3	NA	778.22	Damaged			
PW-4	NA	775.63	9.52	27.50	766.11	
PW-5	NA	775.04	9.53	23.34	765.51	
PW-6	NA	774.24	Damaged			
Surface Water Elevations						
SG-1	NA	NA	NA	NA	781.92	X
SG-2	NA	NA	NA	NA	791.30	X
SG-3 (Alcott Street Dam)	NA	NA	NA	NA	777.58	X
SG-4	NA	NA	NA	NA	769.22	X
SG-5	NA	NA	NA	NA	765.76	X
SG-6	NA	NA	NA	NA	763.41	X
Standing Water Gage on Allied OU	NA	NA	NA	NA	799.66	X

Notes:

[1] The hydrostratigraphic unit screened is identified as lower sand or intermediate/lower sand; however, note that these unit descriptions refer to the lower portion of the *surficial* aquifer.

[2] Intervening clay layers are absent beneath the peat in this area of the Allied OU; therefore, the upper, intermediate and lower sand units can be thought of as one hydrostratigraphic unit within the surficial unit.

[3] Well screens a sand seam within the upper aquitard.

[4] Groundwater level for MW-209 was at the top of casing.

RI = Remedial Investigation.

bgs = below ground surface.

AMSL = above mean sea level.

Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

TOC = Top of casing.

NA = not available.

*Artesian well; measurement is in feet above ground surface and measurement was calculated based on a pressure reading.

Measurements collected on June 26, 2009 were collected while the groundwater exaction system was operating at the Strebor Property; measurements made on July 2, 2009 were collected during a system shutdown.

TOC elevations for non-Allied OU wells and surface water measuring points surveyed by Prein & Newhof in 2009.

Groundwater elevation measurements from the Strebor Property were made by Bay West personnel, while observed by ARCADIS personnel.

Aquifer Unit designations are based on aquifer descriptions in the Remedial Investigation Report (MDEQ, 2008a).

Table 2-4 -- Groundwater Elevation Data at Strebor and Nearby Wells Under Non-Pumping Conditions July 2, 2009

Well Number	Aquifer Unit	7/2/2009	
		Depth to Water (ft below TOC)	Groundwater Elevation (feet AMSL)
Panelyte Property			
MW1	Surficial	8.14	789.02
MW2	Surficial	8.01	787.97
MW7	Surficial	8.29	787.11
MW9	Surficial	1.51	779.60
Strebor Property[1]			
MW-1	Surficial	10.48	792.31
MW-7	Surficial	7.80	787.48
MW-15	Surficial	8.12	789.11
MW-21	Surficial	8.08	786.55
MW-24	Surficial	9.46	790.51
MW-25	Surficial	7.53	787.51
MW-30	Surficial	13.06	783.26
MW-35	Surficial	7.73	787.15
MW-36	Surficial	9.57	778.98
MW-37	Regional	4.89	783.39
MW-38	Surficial	7.82	773.68
MW-39	Regional	8.09*	789.64
MW-40	Regional	5.76	790.75
Performance Paper Property			
ATL-03	Surficial	10.38	767.00
ATL-05	Surficial	9.25	764.17
MW-11	Surficial	7.54	771.42
MW-12S	Surficial	5.43	765.98
Surface Water Elevations			
Alcott Street Dam (SG-3)	Portage Creek	11.77	777.61
SG-4	Portage Creek	19.81	769.12

Notes:
bgs = below ground surface.
AMSL = above mean sea level.
NM = not measured.
TOC = Top of casing.
*Artesian well; measurement is in feet above ground surface and measurement was calculated based on a pressure reading.
Aquifer Unit designations are based on aquifer descriptions in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.
[1] Measurements were made by Bay West personnel and observed by ARCADIS personnel.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
The groundwater extraction system at Strebor was temporary shut down on 7/1/09.
The average pumping rate is approximately 125 gallons per minute.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River/Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table 2-5 - City of Kalamazoo Central Well Field 2006 and 2008 PCB Sampling Data

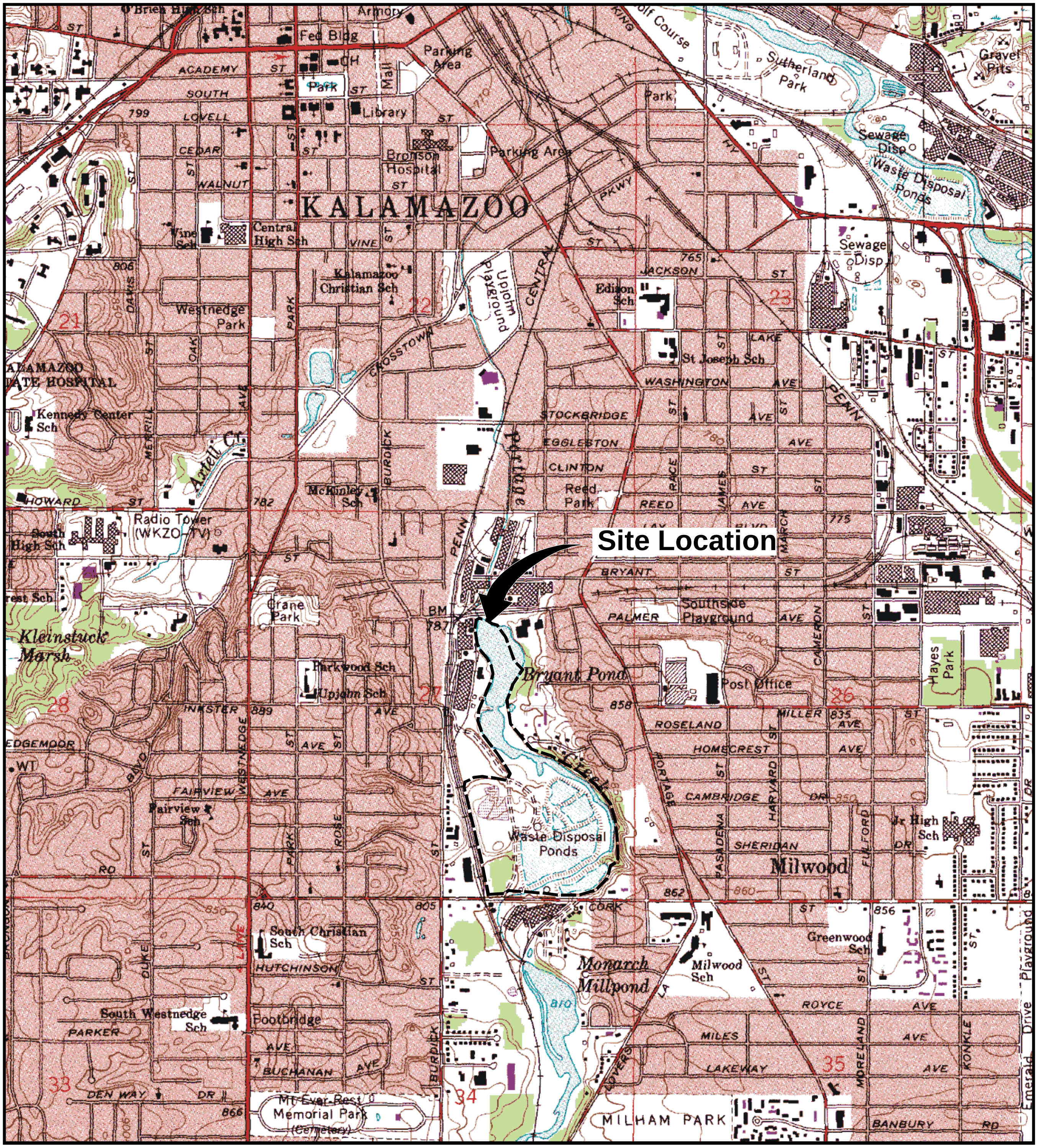
Sample Date	Pumping Station ID	Sample No.	Sample ID	Total PCB (µg/L)[1]
6/28/2006	2	LA 94908	E002 STATION 2	ND (0.05 U)
6/24/2006	1	LA 94908	C001 Central	ND (0.05 U)
8/4/2008	NA	083151-01	"08-217-1-3"	ND (0.05 U)
8/4/2008	NA	083151-02	"08-217-1-5"	ND (0.05 U)
8/4/2008	NA	083151-03	"08-217-1-6"	ND (0.05 U)
8/4/2008	NA	083151-04	"08-217-1-1"	ND (0.05 U)
8/4/2008	NA	083151-07	"08-217-1-4"	ND (0.05 U)
8/4/2008	NA	083151-08	"08-217-1-2"	ND (0.05 U)
8/4/2008	NA	083151-09	"08-217-3-4"	ND (0.05 U)
8/4/2008	NA	083151-10	"08-217-3-5"	ND (0.05 U)
8/4/2008	NA	083151-11	"08-217-3-1"	ND (0.05 U)
8/4/2008	NA	083151-12	"08-217-3-3"	ND (0.05 U)
8/27/2008	3	083589-01	"Sta. 3-2-A, Well 2-A Station 3"	ND (0.05 U)

Notes:
[1]Total PCB included Aroclor 1016, 1221, 1232, 1242, 1248, 1254 and 1260.
ND = not detected.
NA = not available.
µg/L = micrograms per liter.
The analytical data for the City Drinking water chemical analytical results were provided by the City to the USEPA, and subsequently provided to MHLLC by USEPA on September 29, 2008.

Note Explaining Data Qualifiers:
U = The compound was analyzed for but not detected. The associated value is the compound quantitation limit.

ARCADIS

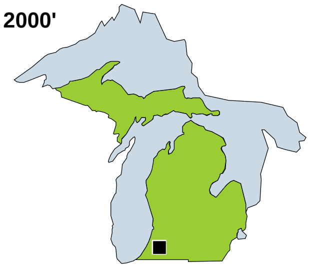
Figures



REFERENCE: BASE MAP SOURCE USGS 7.5 MINUTE QUAD. SERIES KALAMAZOO, MICHIGAN, 1967. (PHOTO REVISED 1973).

2000' 0 2000'

Approximate Scale: 1" = 2000'



Quadrangle Location

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

SITE LOCATION MAP

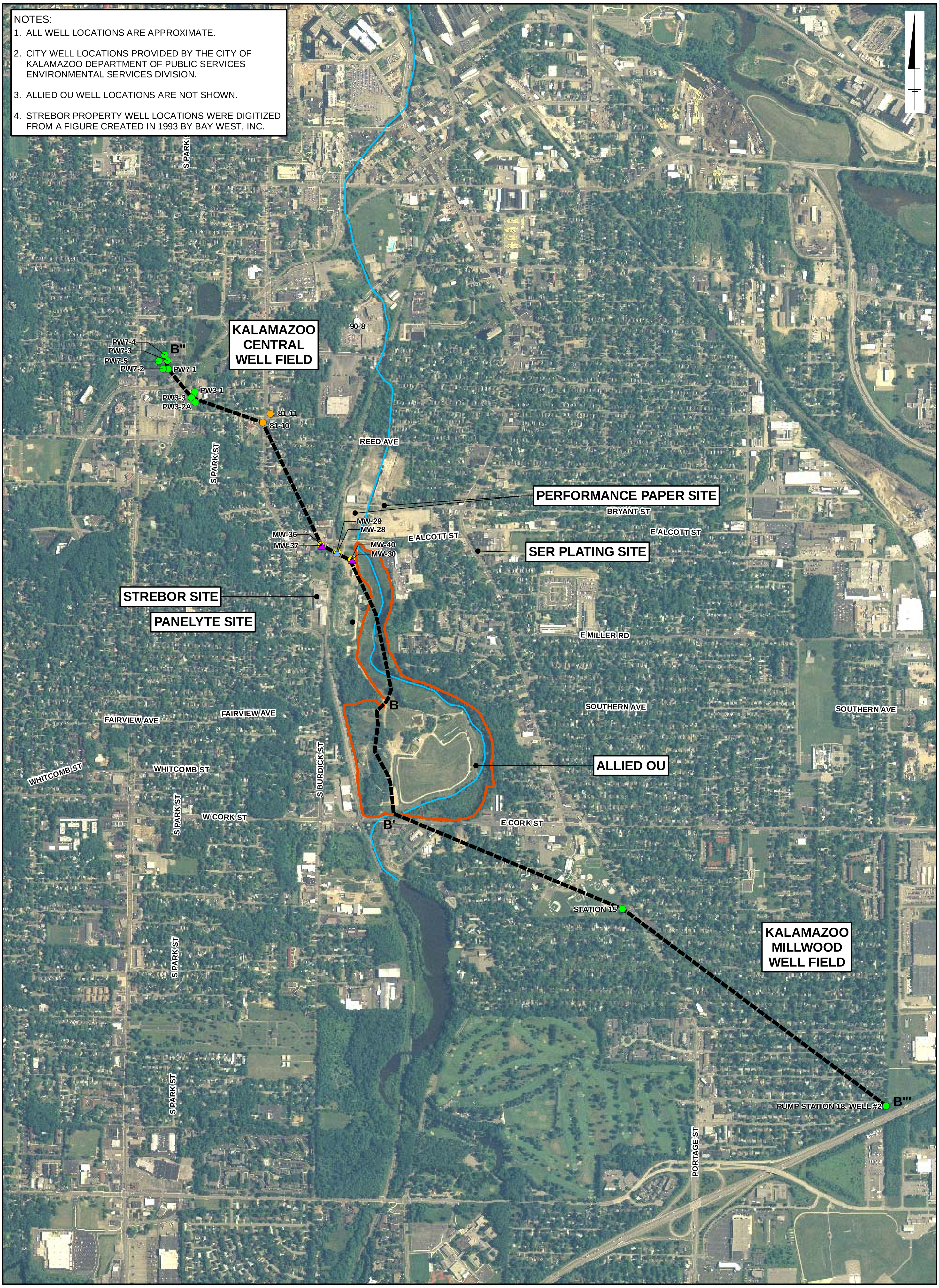
ARCADIS

FIGURE
1-1

08/25/09 SYRACUSE-141ENV-DJHOWES
B0064587/0001/00003/CDR/64587N01.CDR

SYR-90 JCR MTK JCR
KRSG - Allied OU (B0064587.0001.00003)
O:\KRSG\WaterWellLocations\AlliedOU\mxd\CrossSectionLocationMap_v3.mxd - 9/29/2009 @ 4:31:01 PM

NOTES:
1. ALL WELL LOCATIONS ARE APPROXIMATE.
2. CITY WELL LOCATIONS PROVIDED BY THE CITY OF KALAMAZOO DEPARTMENT OF PUBLIC SERVICES ENVIRONMENTAL SERVICES DIVISION.
3. ALLIED OU WELL LOCATIONS ARE NOT SHOWN.
4. STREBOR PROPERTY WELL LOCATIONS WERE DIGITIZED FROM A FIGURE CREATED IN 1993 BY BAY WEST, INC.



LEGEND:
- CITY MONITORING WELL
- CITY PRODUCTION WELL
- STREBOR PROPERTY WATER TABLE MONITORING WELL
- STREBOR PROPERTY INTERMEDIATE MONITORING WELL
- STREBOR PROPERTY DEEP MONITORING WELL
- ALLIED PAPER, INC. OPERABLE UNIT BOUNDARY (APPROXIMATE)
- PORTAGE CREEK CENTERLINE (APPROXIMATE)
- LINE OF CROSS SECTION

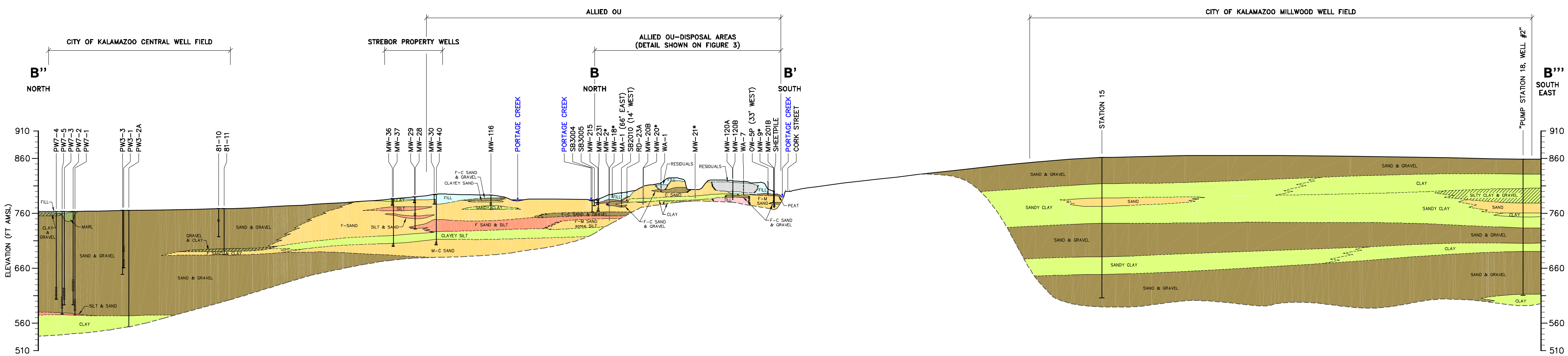
0 1,300 2,600 Feet
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

CROSS-SECTION LOCATION MAP

ARCADIS

FIGURE
1-2



NOTES:

1. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
2. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

SAND AND GRAVEL: INTERBEDDED SAND AND GRAVELS, MAY CONTAIN SMALL AMOUNTS OF SILT AND CLAY.

MARL: UNCONSOLIDATED DEPOSITS OF CLAY AND CALCIUM CARBONATE.

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m–c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

GRAVEL AND CLAY

LEGEND:

SB2010 (14' WEST)*

* NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.
- DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)
- BORING/WELL ID
- SOIL BORING
- MONITORING WELL
- SCREENED INTERVAL
- BOTTOM OF BORING
- INFERRED BOUNDARY
- LIMIT OF AVAILABLE DATA

0 100' 200'
VERTICAL SCALE

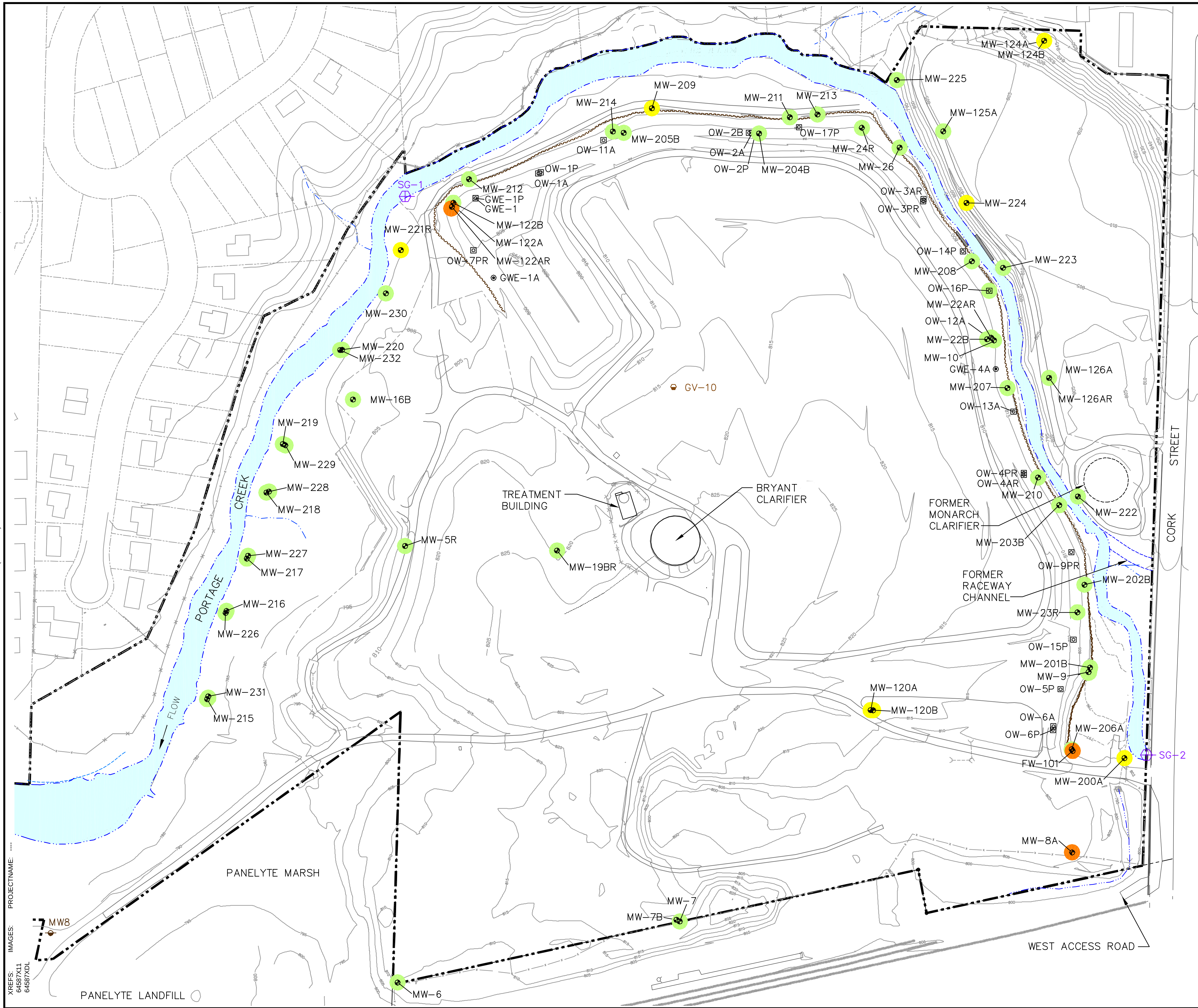
0 600' 1200'
HORIZONTAL SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION B"-B-B'-B'''

ARCADIS

FIGURE
1-3



LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED PROPERTY BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL
- MW-26 — MONITORING WELL
- OW-12A — PIEZOMETER LOCATION
- GWE-1A — RECOVERY WELL LOCATION
- MONITORING WELL SAMPLED IN 2002 AND/OR 2003; PCBs NOT DETECTED
- MONITORING WELL SAMPLED IN 2002 AND/OR 2003; PCBs DETECTED ABOVE GSI CRITERIA
- MONITORING WELL SAMPLED IN 2002 AND/OR 2003; PCBs DETECTED BUT BELOW CRITERIA IN ONE OR BOTH SAMPLES

NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006.
2. ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
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5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.

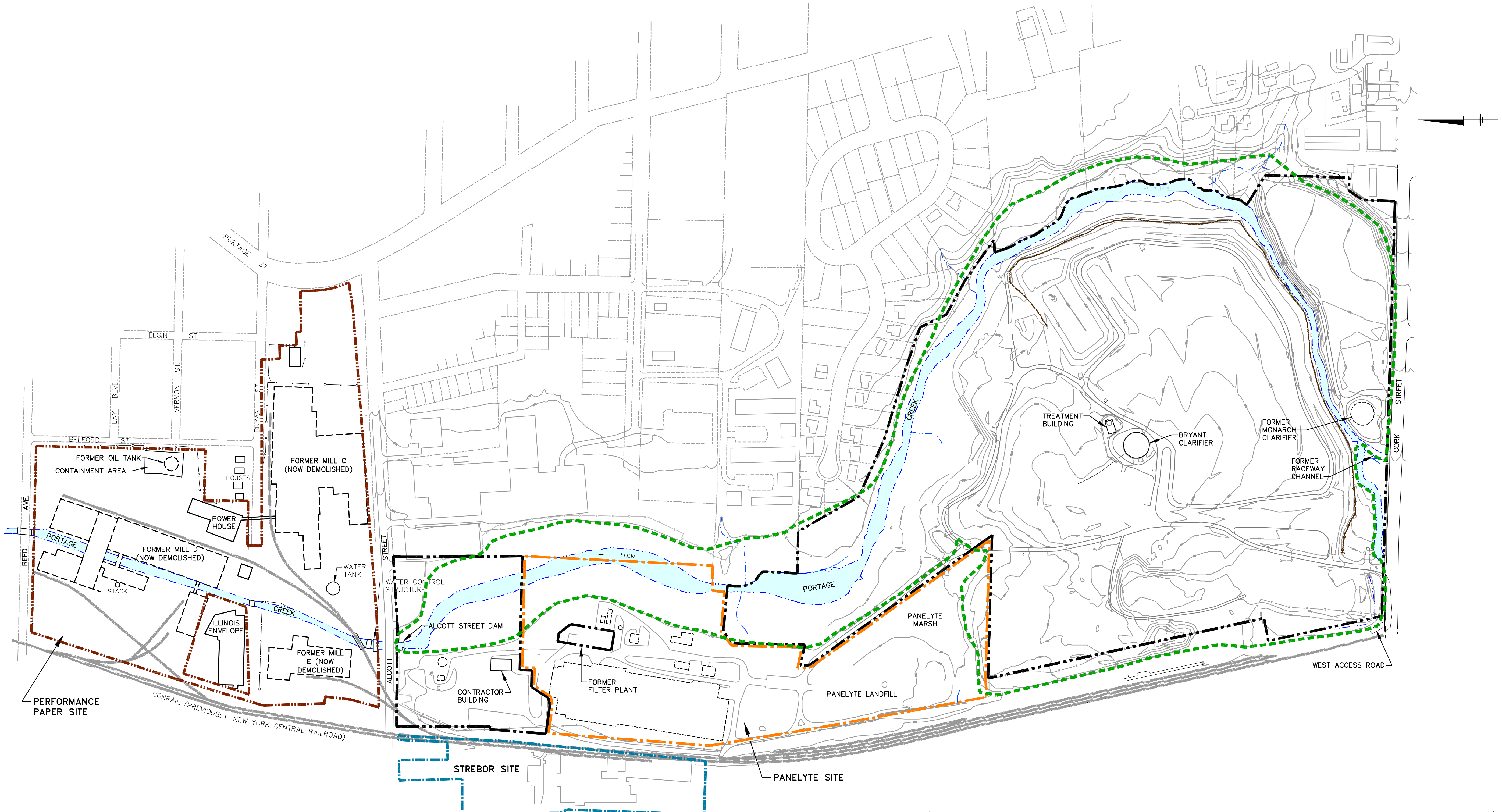
0 100' 200'
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

PCB DETECTIONS IN GROUNDWATER 2002 - 2003

ARCADIS

FIGURE
1-4



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6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. PANELYTE SITE LIMITS WERE DIGITIZED FROM A HARD COPY OF FIGURE 2–1 FROM THE MALCOLM PIRNIE "PRELIMINARY SITE ASSESSMENT REPORT", DATED 12/8/04, AT A SCALE OF 1"=200', AND ARE APPROXIMATE.
8. STREBOR PROPERTY BOUNDARY AND BUILDING DIGITIZED FROM A HARD COPY DOWNLOADED FROM THE CITY OF KALAMAZOO – ONLINE GIS SITE AND ARE APPROXIMATE.

LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED ALLIED OU PROPERTY BOUNDARY
- APPROXIMATE PERFORMANCE PAPER PROPERTY BOUNDARY
- APPROXIMATE PANELYTE SITE LIMITS
- APPROXIMATE STREBOR PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF ALLIED–OU
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL

0 400' 800'

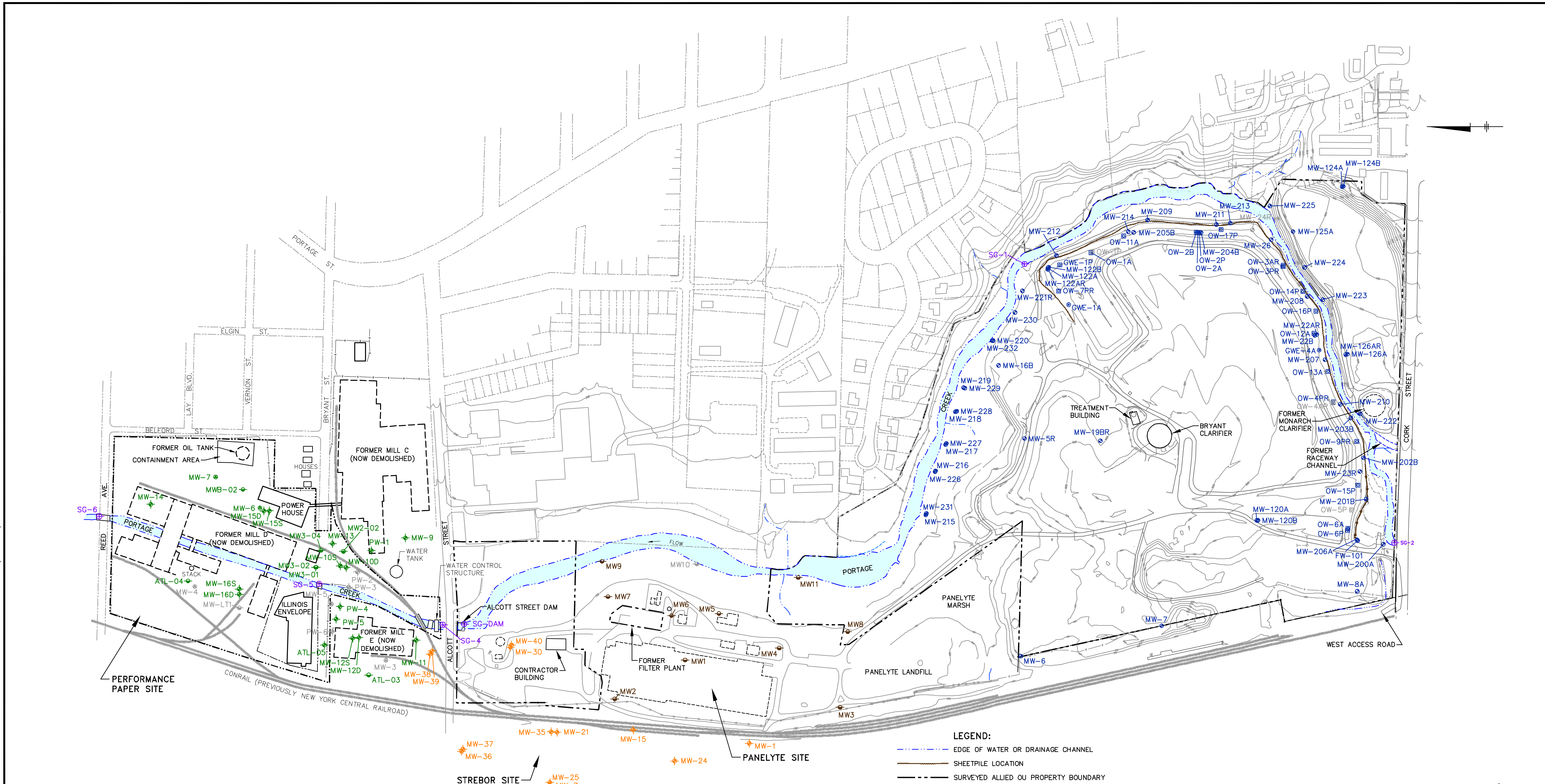
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

NEIGHBORING PROPERTY LOCATION MAP

ARCADIS

FIGURE
2-1



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6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).

LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL
SHEETPILE LOCATION
SURVEYED ALLIED OU PROPERTY BOUNDARY
APPROXIMATE PERFORMANCE PAPER PROPERTY BOUNDARY
TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
RAILROAD TRACK
ROAD/TRAIL

ALLIED OU
MW–26 MONITORING WELL
OW–12A PIEZOMETER LOCATION
GWE–1A RECOVERY WELL LOCATION

PANELYTE MW1 MONITORING WELL INSTALLED BY PANELYTE

STREBOR MW–1 STREBOR WELL LOCATION

PERFORMANCE PAPER
MW–16S MONITORING WELL (ECT–2005)
MW–4 MONITORING WELL (ATLANTIC TESTING–1990)

SG–2 EXISTING SURFACE WATER STAFF GAUGE
MW–4 MONITORING WELL NOT LOCATED OR DAMAGED

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

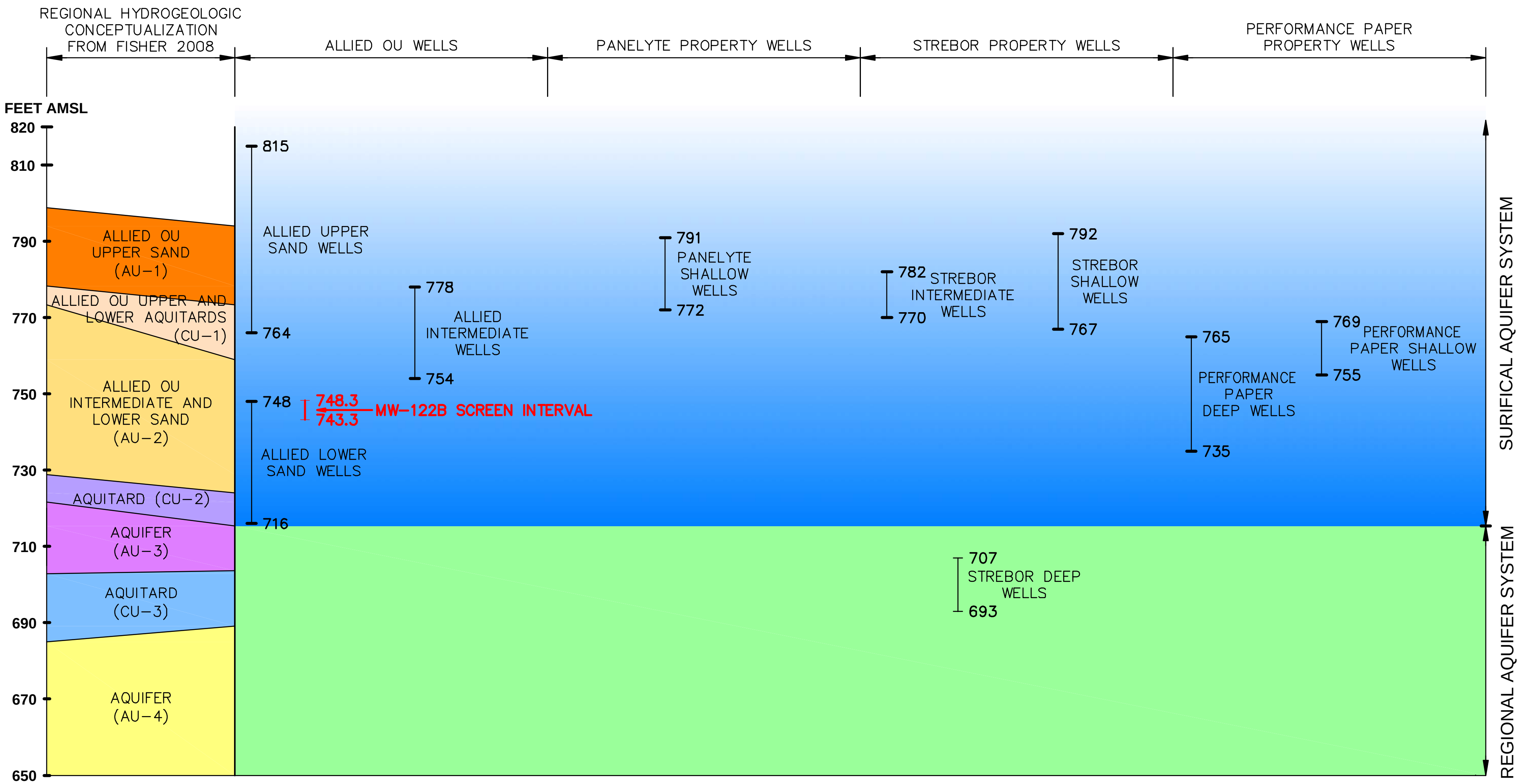
GROUNDWATER INVESTIGATION MONITORING LOCATIONS

ARCADIS

FIGURE
2-2

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: R.ALLEN, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: L. COFFEY TR: J. ROBERTSON LYR:ON=*;OFF=*REF* PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 2:59 PM BY: JONES, WENDY
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\64587B08.DWG LAYOUT: 2-2 SAVED: 9/3/2009 2:58 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----
XREFS: 64587X11 64587XDL IMAGES: PROJECTNAME: ----

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: G.STOWELL, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: L. COFFEY TR: J. ROBERTSON LYR: ON=*;OFF=REF
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\PRESENTATION\64387N02.dwg LAYOUT: 2-3SAVED: 9/3/2009 2:56 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 2:57 PM BY: JONES, WENDY
XREFS: IMAGES: PROJECTNAME: ----



NOTES:

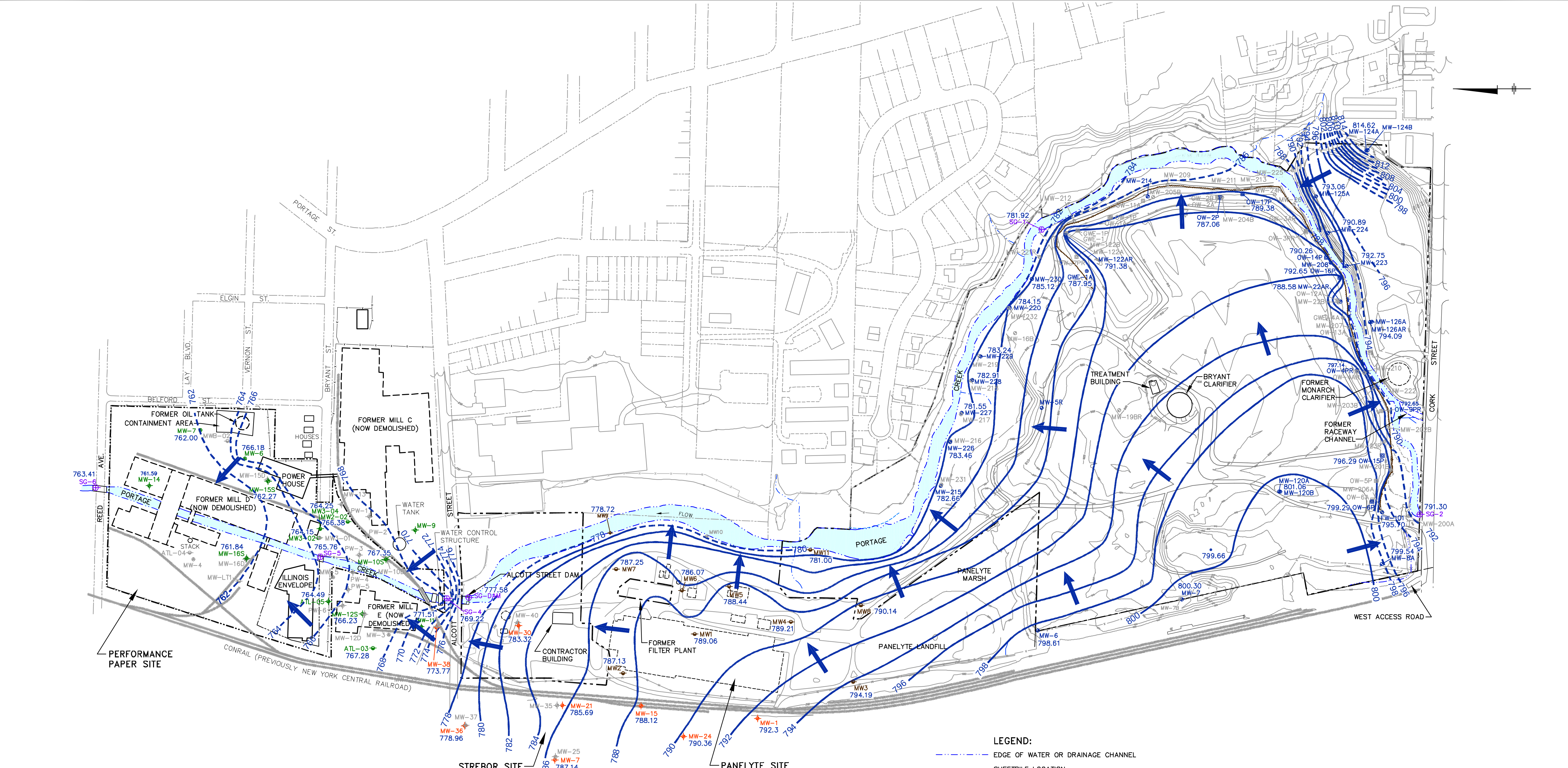
1. REGIONAL HYDROGEOLOGIC CENCEPTUALIZATION ADAPTED FROM FIGURE 2 FROM BRANT FISHER, APRIL 30 2008 MDEQ MEMORANDUM TO PAUL BUCHOLTZ, TITLED HYDROGEOLOGIC CONCEPTUALIZATION.
2. MONITORING WELL ELEVATION RANGES SHOWN ARE ONLY FOR MONITORING WELLS INCLUDED IN JUNE 2009 GROUNDWATER INVESTIGATION.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

MONITORING WELL SCREEN INTERVALS RELATIVE TO REGIONAL HYDROGEOLOGIC UNITS

ARCADIS

FIGURE
2-3



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7. MONITORING WELLS SHADED GRAY NOT USED TO GENERATE GROUNDWATER CONTOURS.
8. MONITORING WELLS MW-6, MW-7, MW-8A, MW-125A AND MW-126AR ARE NOT TRUE WATER TABLE WELLS (i.e., THE WATER TABLE IS NOT WITHIN THE SCREENED INTERVAL), RATHER THEY ARE SCREENED SLIGHTLY BELOW THE WATER TABLE. DATA FROM THESE WELLS WERE JUDGED TO REPRESENT A REASONABLE APPROXIMATION OF THE WATER TABLE AND AS SUCH WERE USED TO GUIDE CONTOURING IN AREAS OF SPARSE DATA.

LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL
SHEETPILE LOCATION
SURVEYED PROPERTY BOUNDARY
APPROXIMATE PROPERTY BOUNDARY
TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
RAILROAD TRACK
ROAD/TRAIL

ALLIED OU
MW-26 MONITORING WELL
OW-12A PIEZOMETER LOCATION
GWE-1A RECOVERY WELL LOCATION

PANELYTE
MW1 MONITORING WELL INSTALLED BY PANELYTE

STREBOR
MW-1 STREBOR WELL LOCATION

PERFORMANCE PAPER
MW-16S MONITORING WELL (ECT-2005)
MW-4 MONITORING WELL (ATLANTIC TESTING-1990)

SG-2 EXISTING SURFACE WATER STAFF GAUGE
STANDING WATER ELEVATION (FEET)
795.7 GROUNDWATER ELEVATION (IN FEET)
798 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)

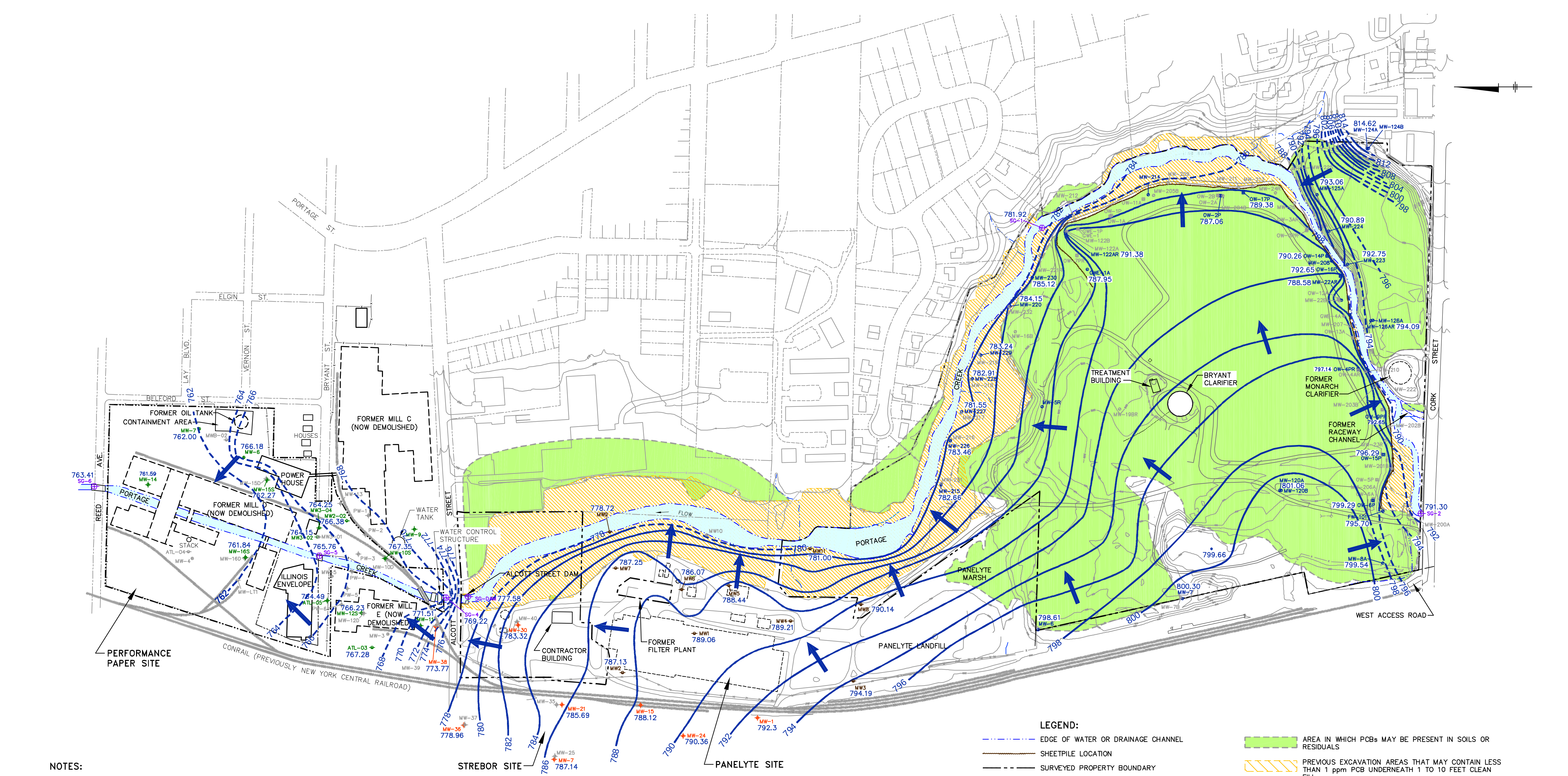
0 400' 800'
GRAPHIC SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WATER TABLE CONTOUR MAP
JUNE 25 - 26, 2009

ARCADIS

FIGURE
3-1



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9. THE LIMITS OF THE USEPA EXCAVATION WERE COPIED FROM FIGURE 4–2 OF THE ALLIED PAPER/PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE FINAL REPORT, PREPARED BY WESTON, JANUARY 2000; HOWEVER, THE SURVEYED EXCAVATION BOUNDARY PROVIDED BY THE USEPA HAS BEEN MODIFIED BASED ON FIELD OBSERVATIONS TO MORE ACCURATELY REFLECT SITE CONDITIONS.
10. FIGURE BASED ON FIGURE 35A FROM 2003 RI REMEDIAL INVESTIGATION REPORT (BBL, 2003).

LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL
SHEETPILE LOCATION
SURVEYED PROPERTY BOUNDARY
APPROXIMATE PROPERTY BOUNDARY
TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
RAILROAD TRACK
ROAD/TRAIL
ALLIED OU — MW-26 MONITORING WELL; OW-12A PIEZOMETER LOCATION; CWE-1A RECOVERY WELL LOCATION
PANELYTE — MW1 MONITORING WELL INSTALLED BY PANELYTE
STREBOR — MW-1 STREBOR WELL LOCATION
PERFORMANCE PAPER — MW-16S MONITORING WELL (ECT–2005); MW-4 MONITORING WELL (ATLANTIC TESTING–1990)
SG-2 EXISTING SURFACE WATER STAFF GAUGE
STANDING WATER ELEVATION (FEET)
795.7 GROUNDWATER ELEVATION (IN FEET) (6/25/09–6/26/09)
798 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
AREA IN WHICH PCBs MAY BE PRESENT IN SOILS OR RESIDUALS
PREVIOUS EXCAVATION AREAS THAT MAY CONTAIN LESS THAN 1 ppm PCB UNDERNEATH 1 TO 10 FEET CLEAN FILL

0 400' 800'
GRAPHIC SCALE

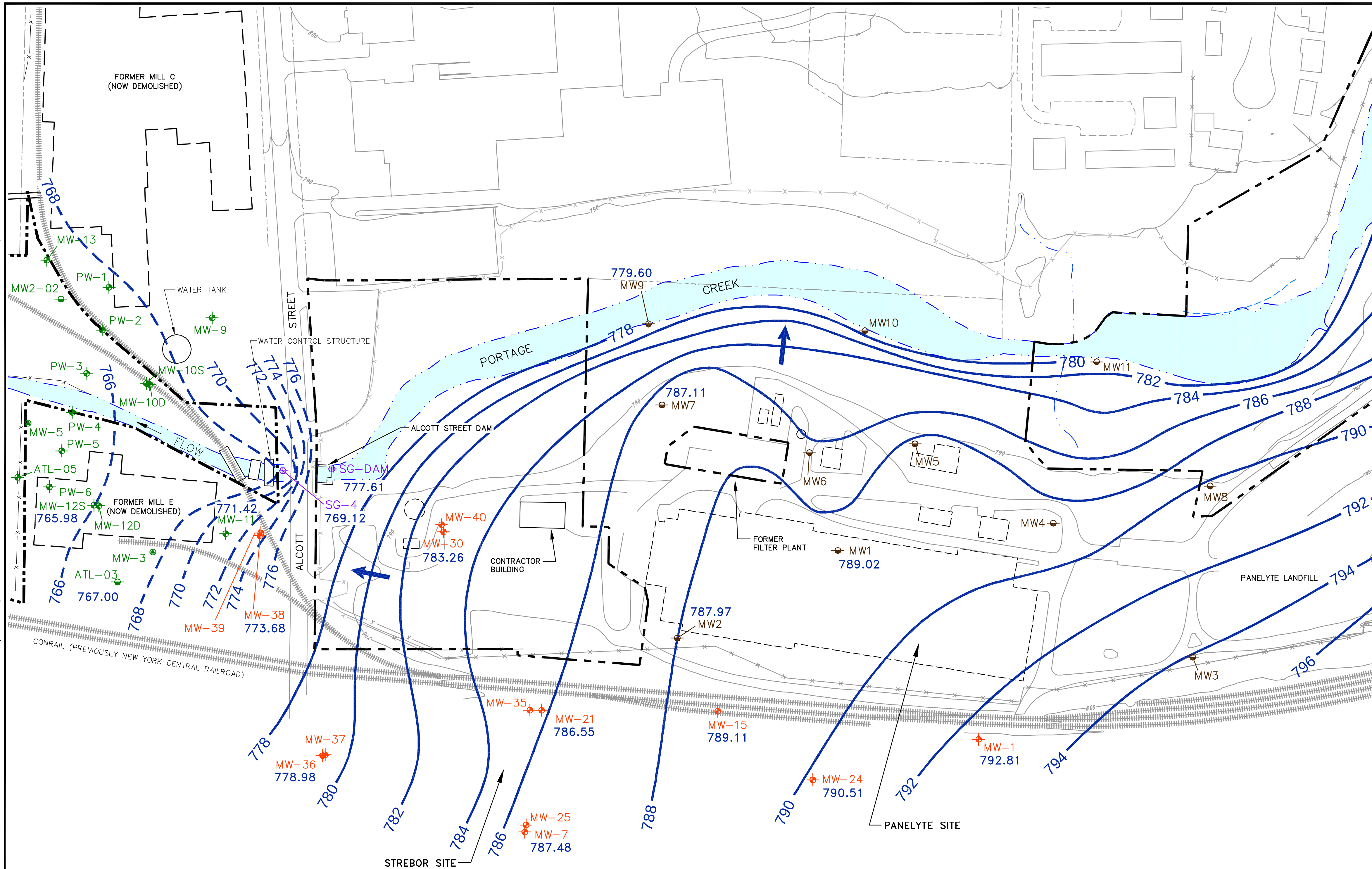
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WATER TABLE CONTOUR MAP - JUNE 25 - 26, 2009 AND POTENTIAL EXTENT OF RESIDUALS

ARCADIS

FIGURE
3-2

CITY: SYRACUSE, NY GROUP: ENVCAD DB: R.ALLEN G.STOWELL P. LISTER TR: J. ROBERTSON LYR:ON=*;OFF=REF,(FRZ) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 3:04 PM BY: JONES, WENDY
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\64587W07.DWG LAYOUT: 3-2 SAVED: 9/3/2009 1:49 PM ACADVER: 17.0S (LMS TECH)
XREFS: 64587X11 64587XDL IMAGES: PROJECTNAME: ----



LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL
SURVEYED PROPERTY BOUNDARY
APPROXIMATE PROPERTY BOUNDARY
810 TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
RAILROAD TRACK
ROAD/TRAIL

PANELYTE — MW1 — MONITORING WELL INSTALLED BY PANELYTE
STREBOR — MW-1 — STREBOR WELL LOCATION
PERFORMANCE PAPER — MW-16S — MONITORING WELL (ECT-2005)
PERFORMANCE PAPER — MW-4 — MONITORING WELL (ATLANTIC TESTING-1990)
SG-4 — EXISTING SURFACE WATER STAFF GAUGE
795.7 — GROUNDWATER ELEVATION (IN FEET)
798 — GROUNDWATER ELEVATION CONTOUR

0 200' 400'
GRAPHIC SCALE

NOTES:

1. TOPOGRAPHIC MAPPING NORTH OF FORMER TYPE III LANDFILL AREA, AND BRYANT HRDLs/FRDLs PRODUCED USING PHOTOGRAMETRIC METHODS BY LOCKWOOD, INC. FROM AERIAL PHOTOGRAPHY FLOWN MAY 1991. BASE MAP INFORMATION WITHIN FORMER TYPE III LANDFILL AREA AND AREA NORTH OF WESTERN DISPOSAL AREA FIELD SURVEY OBTAINED FROM PLAN ENTITLED "TOPOGRAPHIC AND BOUNDARY SURVEY OF ALLIED PAPER, INC. KALAMAZOO, MI. SECTION 27. TOWN 2 SOUTH, RANGE 11 WEST," PREPARED BY WADE-TRIM, INC., DATED 7/8/99. BASE MAP INFORMATION WITHIN BRYANT HRDLs/FRDLs AREA OBTAINED FROM PLAN ENTITLED "AS BUILT SURVEY OF ALLIED PAPER SITE" PREPARED BY PREIN AND NEWHOF, KALAMAZOO, MI. DATED 1/27/05 (PROJECT NO. 2000171K). TOPOGRAPHIC CONTOUR LINES INSIDE THE MONARCH HRDL AREA SURVEYED BY PREIN & NEWHOF SURVEYORS ON 4/03. NGVD 1929. BASE MAP INFORMATION IN THE WESTERN DISPOSAL AREA BASED ON TOPOGRAPHIC SURVEY PERFORMED BY PREIN & NEWHOF, DRAWING FILE NUMBER 2060643K, DATED SEPTEMBER 27, 2006. BASE MAP INFORMATION AND PERFORMANCE PAPER WELL LOCATIONS BY MACTEC (2002), AND ATLANTIC TESTING (1990) NORTH OF ALCOTT STREET PREPARED BY DIGITIZING A PAPER COPY OF A PDF OF A DRAWING MADE BY "FISHBECK, THOMPSON, CARR & HUBER ENGINEERS-SCIENTISTS-ARCHITECTS" TITLED BASELINE ENVIRONMENTAL ASSESSMENT-SITE PLAN PROJECT NUMBER G03561A, DATED 2005, AT A SCALE OF 1"=150'. PERFORMANCE PAPER WELL LOCATIONS BY "ENVIRONMENTAL CONSULTING & TECHNOLOGY, INC." (ECT), DIGITIZED FROM PAPER COPY OF A PDF OF A DRAWING MADE BY "ECT" TITLED "SITE MAP WITH SAMPLING LOCATIONS - FIGURE 4", DATED 2005, AT A SCALE OF 1"=200'.
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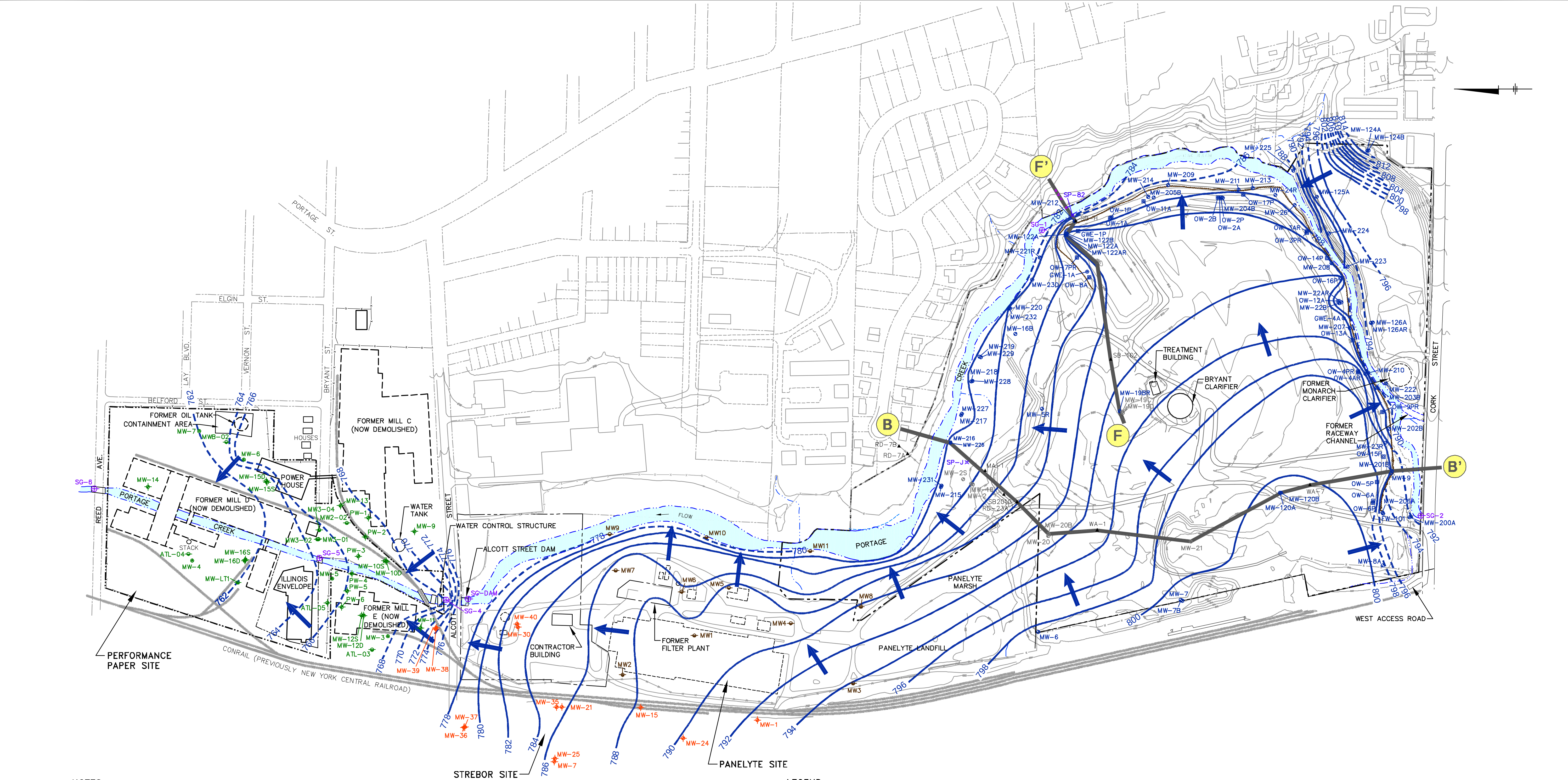
3. COORDINATE GRID IS REFERENCED TO THE MICHIGAN STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM (NAD83).
4. ALLIED PROPERTY LINES ESTABLISHED USING: WADE-TRIM SURVEY (9/1999)-NORTHERN PARCEL ONLY; ATWELL HICKS, INC. SURVEY (11/2002); AND PREIN AND NEWHOF SURVEY (12/2002).
5. PORTAGE CREEK OUTLINE WITHIN THE ALLIED PROPERTY UPDATED ON 12/4/02 USING DIGITAL ORTHOGRAPHY BY AIR LAND SURVEYS, INC.(4/24/00) SCANNED FROM CDM DRAWING DETSVR/DETL007770/C:/PROJ/28963/_GIS/OU1/OU1_REPORT.APR REVISED 11/10/02. PORTAGE CREEK OUTLINE NORTH OF THE ALLIED PROPERTY UPDATED ON 12/4/02 USING A CDM CREEK OUTLINE PREPARED ON 9/23/02 PROVIDED ON COMPACT DISK.
6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. GROUNDWATER ELEVATIONS WERE COLLECTED DURING A SHUTDOWN PERIOD OF THE STREBOR GROUNDWATER EXTRACTION SYSTEM.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WATER TABLE CONTOUR MAP
JULY 2, 2009

ARCADIS

FIGURE
3-3



NOTES:

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6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).

LEGEND:

EDGE OF WATER OR DRAINAGE CHANNEL
SHEETPILE LOCATION
SURVEYED PROPERTY BOUNDARY
APPROXIMATE PROPERTY BOUNDARY
TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
RAILROAD TRACK
ROAD/TRAIL

ALLIED OU
- MW-28 MONITORING WELL
- OW-12A PIEZOMETER LOCATION
- GWE-1A RECOVERY WELL LOCATION

PANELYTE
- MW1 MONITORING WELL INSTALLED BY PANELYTE

STREBOR
- MW-1 STREBOR WELL LOCATION

PERFORMANCE PAPER
- MW-16S MONITORING WELL (ECT-2005)
- MW-4 MONITORING WELL (ATLANTIC TESTING-1990)

SG-2 EXISTING SURFACE WATER STAFF GAUGE
798 WATER TABLE ELEVATION CONTOUR (DASHED WHERE INFERED) JUNE 25 – 26, 2009
F — F' FLOW NET LOCATION

0 400' 800'
GRAPHIC SCALE

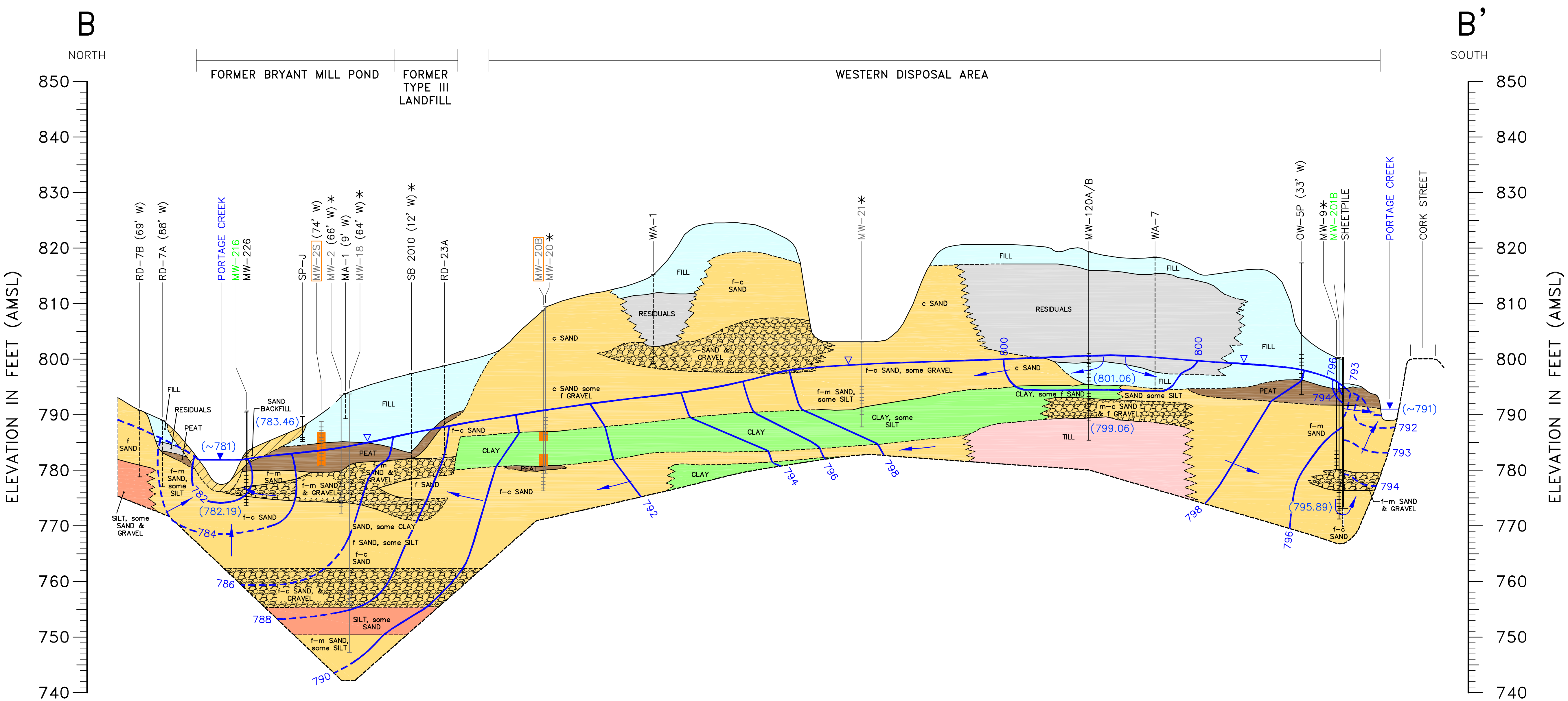
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GROUNDWATER FLOW NET CROSS SECTION LOCATION MAP

ARCADIS

FIGURE
3-4

CITY: SYRACUSE, NY GROUP: ENVCAD-141 DB: R.ALLEN, P. LISTER, R.ALLEN PM: T. GRANZEIER TM: L. COFFEY TR: J. ROBERTSON LYR:ON=*;OFF=REF (FRZ) PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 1:53 PM BY: JONES, WENDY
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00003\DWG\64587V01.DWG LAYOUT: 3-4 SAVED: 9/3/2009 1:52 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----
XREFS: 64587X11 64587XDL IMAGES: PROJECTNAME: ----



LEGEND:

MW-10	SOIL BORING/SINGLE-CASED WELL
MW-205B	DOUBLE-CASED WELL
MW-2S	BORING/WELL LOCATION WITH GEOTECHNICAL SAMPLE(S) COLLECTED AND ANALYZED
GV-09	GAS VENT

MW-1 (11' E)*

- * NOT CONTINUOUSLY SAMPLED. SAMPLED AT 5 FOOT INTERVALS.
- (11' E) DISTANCE AND DIRECTION FROM WHICH BORING/WELL IS PROJECTED ONTO SECTION LINE (IF GREATER THAN 10 FEET)
- MW-1 BORING/WELL ID
- APPROXIMATE SURFACE WATER ELEVATION
- WATER TABLE 6/25–26/09 (DASHED WHERE INFERRED)
- GAS VENT
- PERMANENT SUMP
- SHEET PILE (SEE NOTE 6)
- SOIL BORING
- ABANDONED MONITORING WELL
- MONITORING WELL
- GEOTECHNICAL SAMPLE INTERVAL
- SCREENED INTERVAL
- (782.19) GROUNDWATER ELEVATION 6/25 – 26/09
- BOTTOM OF BORING

FILL: CONSISTS CHIEFLY OF A HETEROGENEOUS MIXTURE OF SAND AND SILT WITH VARIABLE AMOUNTS OF GRAVEL AND OCCASIONAL DISCONTINUOUS INTERVALS OF REWORKED PEAT. MAY CONTAIN TRACE AMOUNTS OF RESIDUALS.

SAND BACKFILL: EXTENT (VERTICAL & HORIZONTAL) OF SAND BACKFILL PLACED FOLLOWING THE USEPA'S REMOVAL ACTION AT THE FORMER BRYANT MILL POND IS BASED ON A REVIEW OF THE FINAL REPORT (WESTON, 2000). TOTAL DEPTH OF EXCAVATION WAS NOT PROVIDED WITHIN THE REPORT.

RESIDUALS: RESIDUALS MAY CONTAIN THIN LAYERS OF SAND OR OTHER FILL.

PEAT: DEPOSITS OF POST-GLACIAL AGE CONSISTING OF PEAT OR ORGANIC-RICH SILT OR CLAY.

SAND: PREDOMINANT GRAIN SIZE OF SAND SHOWN AS FINE [f], MEDIUM [m], OR COARSE [c]. MAY CONTAIN SMALL AMOUNTS OF CLAY, SILT, OR GRAVEL.

GRAVEL: GRAVEL MAY CONTAIN SMALL AMOUNTS OF f–c SAND, SILT AND CLAY.

CLAY: CLAY MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND SILT.

SILT: SILT MAY CONTAIN SMALL AMOUNTS OF f–c SAND AND CLAY.

TILL: A GENERALLY HARD DEPOSIT WITH LITTLE OR NO SORTING AND CONSISTING CHIEFLY OF f SAND, SILT, AND/OR CLAY IN VARYING PROPORTIONS, WITH LESSER AMOUNTS OF m–c SAND AND GRAVEL. MAY CONTAIN OCCASIONAL, DISCONTINUOUS LENSES OF SILT, SAND, AND/OR GRAVEL.

NOTES:

1. SURFACE–WATER ELEVATIONS ARE APPROXIMATE AND ARE BASED ON INTERPOLATION BETWEEN GAUGES.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA.
4. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
5. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
6. REFRACTION ANGLES OF EQUIPOTENTIAL LINES ARE APPROXIMATE. THE FLOW NET AS ILLUSTRATED IS CONCEPTUAL AND CONSISTENT WITH AVAILABLE DATA.

10' 0 10' 20'
VERTICAL SCALE

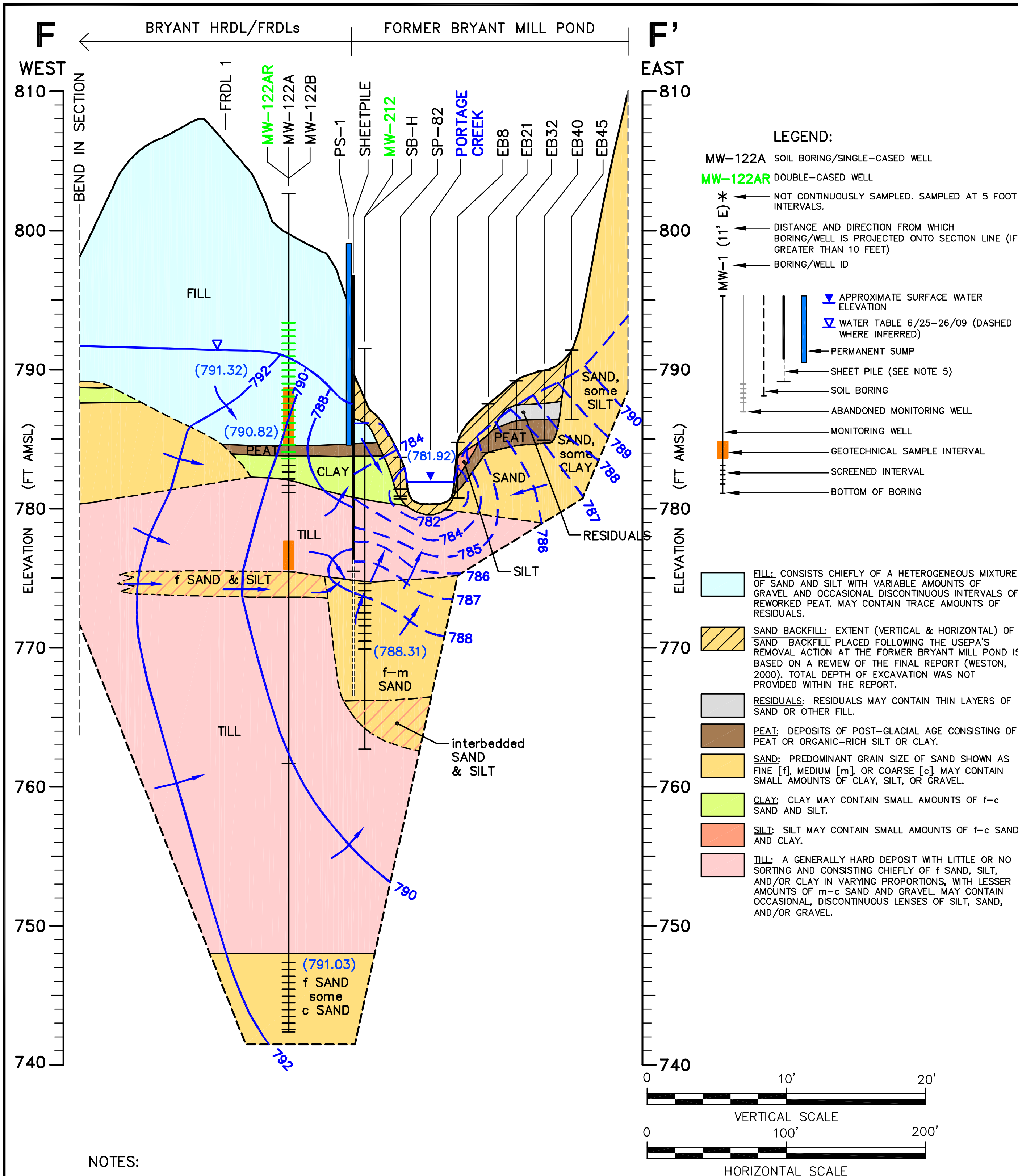
100' 0 100' 200'
HORIZONTAL SCALE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION B-B'
GROUNDWATER FLOW NET
JUNE 25-26, 2009

ARCADIS

FIGURE
3-5



NOTES:

1. CREEK WATER ELEVATION APPROXIMATE.
2. DASHED LINES BETWEEN UNITS REPRESENT INFERRED BOUNDARIES.
3. SURFACE ELEVATIONS FROM TOPOGRAPHIC MAPPING BY LOCKWOOD MAPPING, INC., AND MONITORING WELL/BORING SURVEY DATA. GROUND SURFACE UPDATED BASED ON SURVEYS BY WADE TRIM, DATED 7/8/99, AND PREIN AND NEWHOF, DATED 1/27/05.
4. AMSL = ABOVE MEAN SEA LEVEL (NGVD OF 1929).
5. THE DASHED PORTION OF THE SHEET PILE ILLUSTRATES THE HIGHEST AND LOWEST DRIVEN DEPTH OF THE PILING WITHIN 20 FT. OF EITHER SIDE OF THE LINE OF SECTION. THE HORIZONTAL LINE DEPICTS THE DRIVEN DEPTH OF THE SHEET PILE ALONG THE LINE OF SECTION.
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MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

GEOLOGIC CROSS SECTION F-F'
GROUNDWATER FLOW NET
JUNE 25 - 26, 2009

ARCADIS

FIGURE
3-6

CITY:SYRACUSE, N.Y. DIV/GROUP:ENVCAD-141 DB:R.ALLEN LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* ---PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 3:02 PM BY: JONES, WENDY
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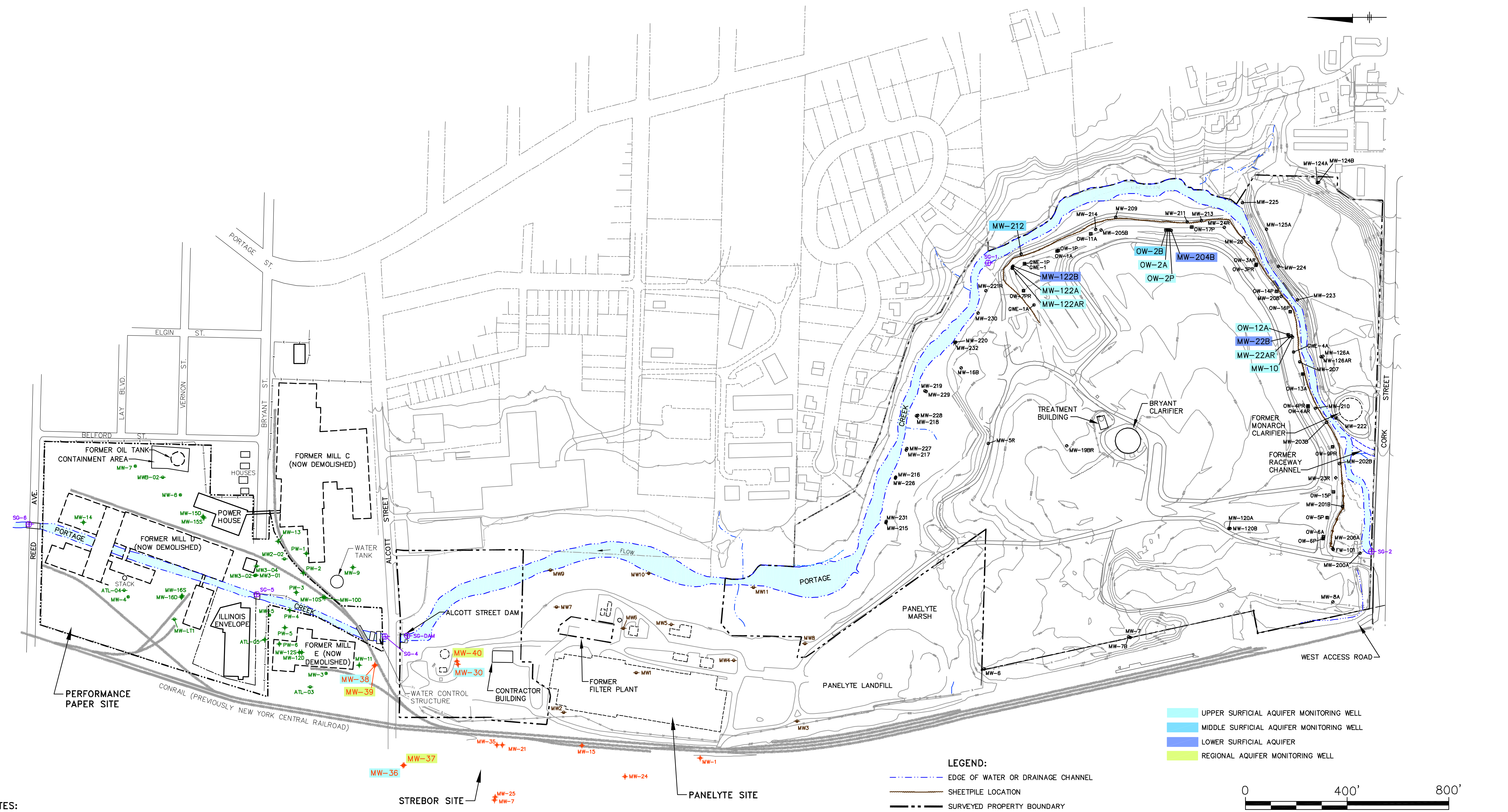

NOTES:

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6. PERFORMANCE PAPER, STREBOR AND PANELYTE SITE MONITORING WELLS SURVEY BY PREIN AND NEWHOF (6/2009).
7. MW-204B COULD POTENTIALLY BE SCREENED AT THE TOP OF THE REGIONAL AQUIFER, HOWEVER SITE BORING DATA ARE NOT EXTENSIVE ENOUGH AT DEPTH TO CONFIRM THIS.

LEGEND:

- EDGE OF WATER OR DRAINAGE CHANNEL
- SHEETPILE LOCATION
- SURVEYED PROPERTY BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY
- TOPOGRAPHIC CONTOUR LINE (SEE NOTE 1)
- RAILROAD TRACK
- ROAD/TRAIL

ALLIED OU
- MW-26 SINGLE-CASED MONITORING WELL OR CLUSTER
- MW-203B DOUBLE-CASED MONITORING WELL
- OW-12A PIEZOMETER LOCATION
- GWE-1A RECOVERY WELL LOCATION

PANELYTE
- MW1 MONITORING WELL INSTALLED BY PANELYTE

STREBOR
- MW-1 STREBOR WELL LOCATION

PERFORMANCE PAPER
- MW-16S MONITORING WELL (ECT-2005)
- MW-4 MONITORING WELL (ATLANTIC TESTING-1990)

- SG-2 EXISTING SURFACE WATER STAFF GAUGE

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC. / PORTAGE CREEK /
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

WELL CLUSTER LOCATION MAP

ARCADIS

FIGURE
3-7

CITY: SYRACUSE, NY GROUP: ENVCAD DB: R.ALLEN, L.POSENAUER, P. LISTER PM: T. GRANZEIER TM: L.COFFEY TR: J. ROBERTSON LYR: ON=*;OFF=REF (FRZ) PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/3/2009 1:57 PM BY: JONES, WENDY
G:\ENVCAD\SYRACUSE\ACT\B0064587\0001\00004\DWG\64587W08.DWG LAYOUT: 3-7 SAVED: 9/2/2009 3:58 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ---- PROJECTNAME: ----
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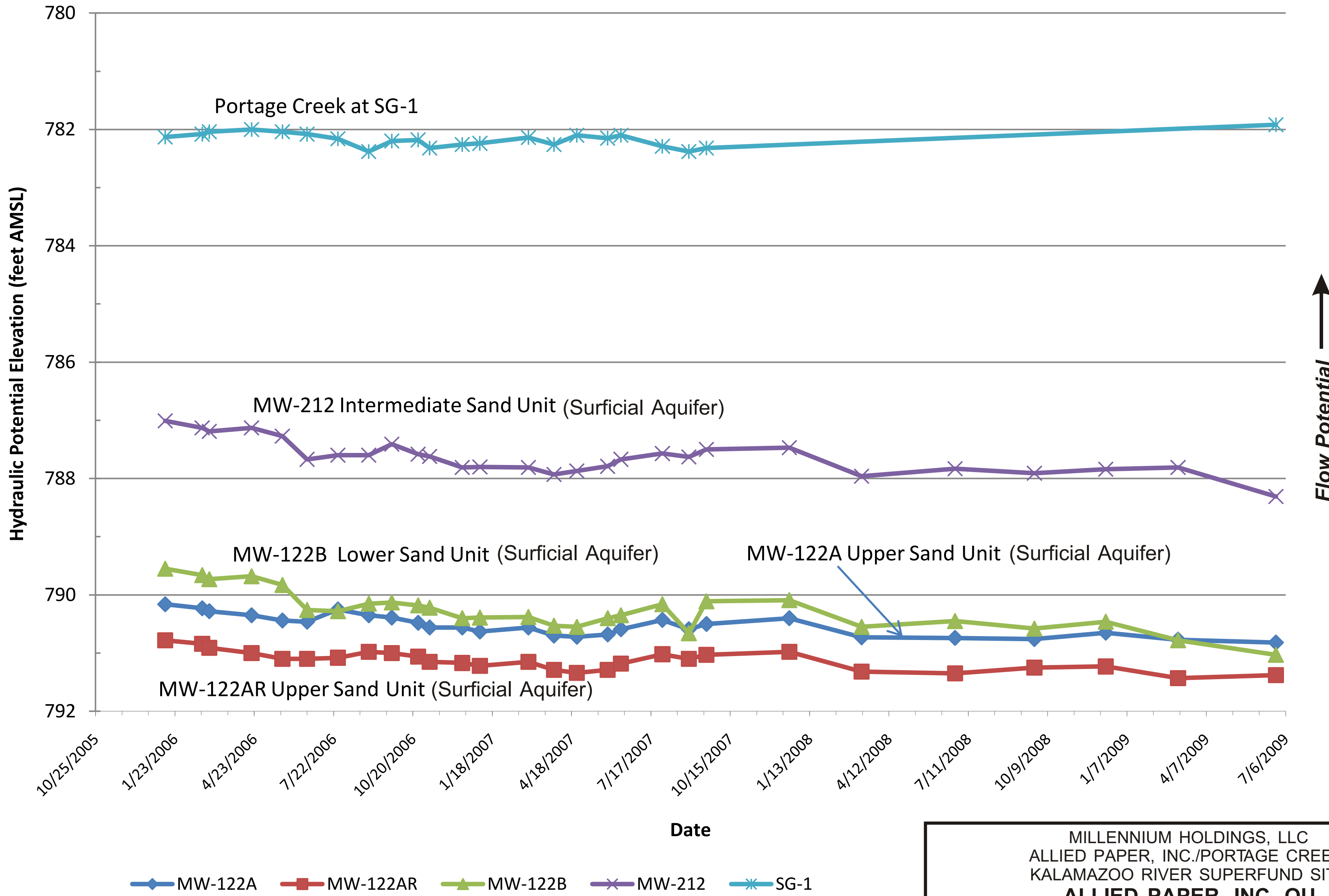


The data show a downward flow potential from the upper sand unit to the intermediate sand unit and an upward flow potential from the lower sand unit to the intermediate sand. Portage Creek is at the lowest elevation, and serves as the discharge point for groundwater present in the upper, intermediate, and lower sand units.

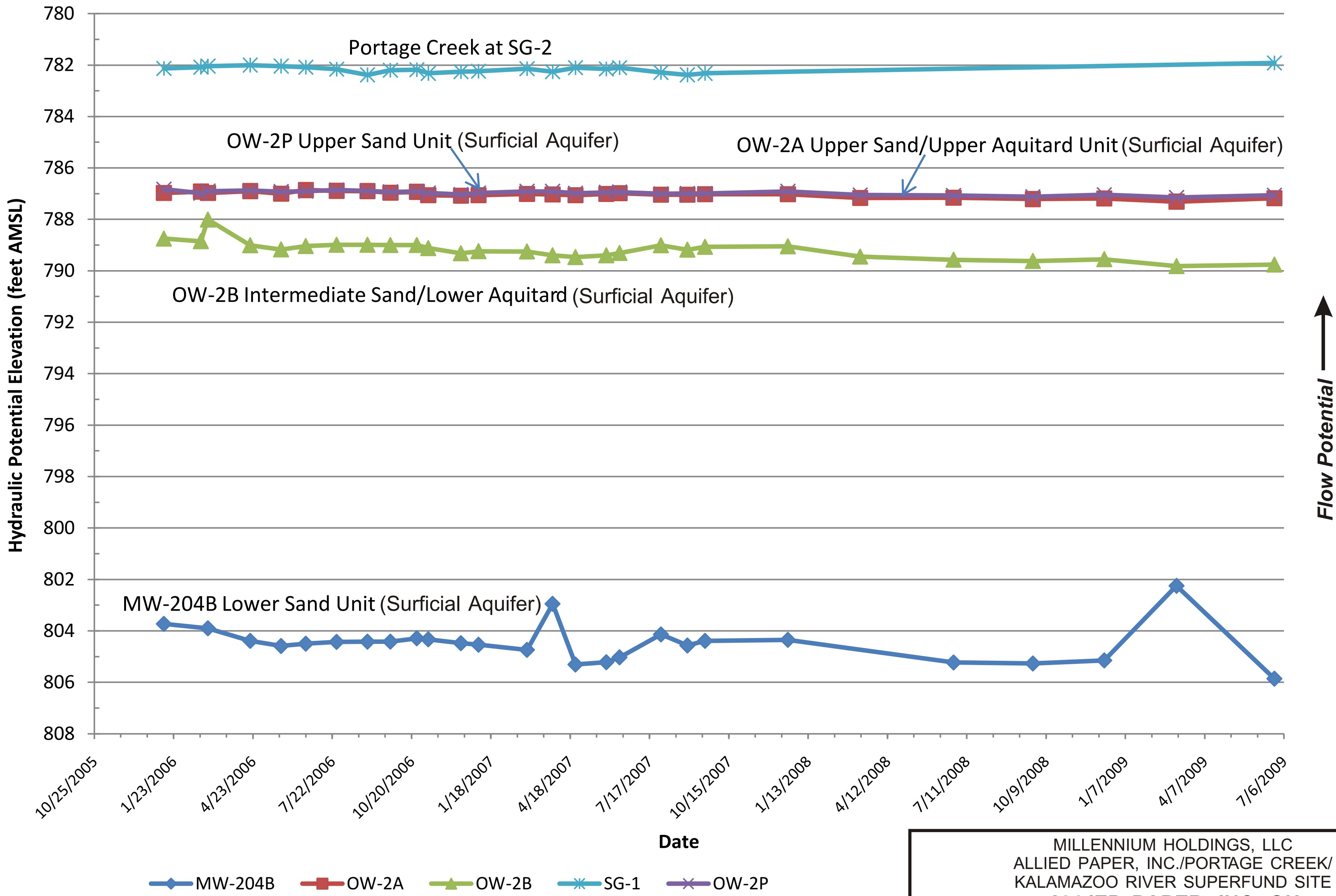
MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALLIED OU - MW-122/MW-212 WELL CLUSTER GROUNDWATER ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-8

09/30/09 SYRACUSE-141ENV-DJHOWES
B0064587/0001/00003/CDR/64587G06.CDR



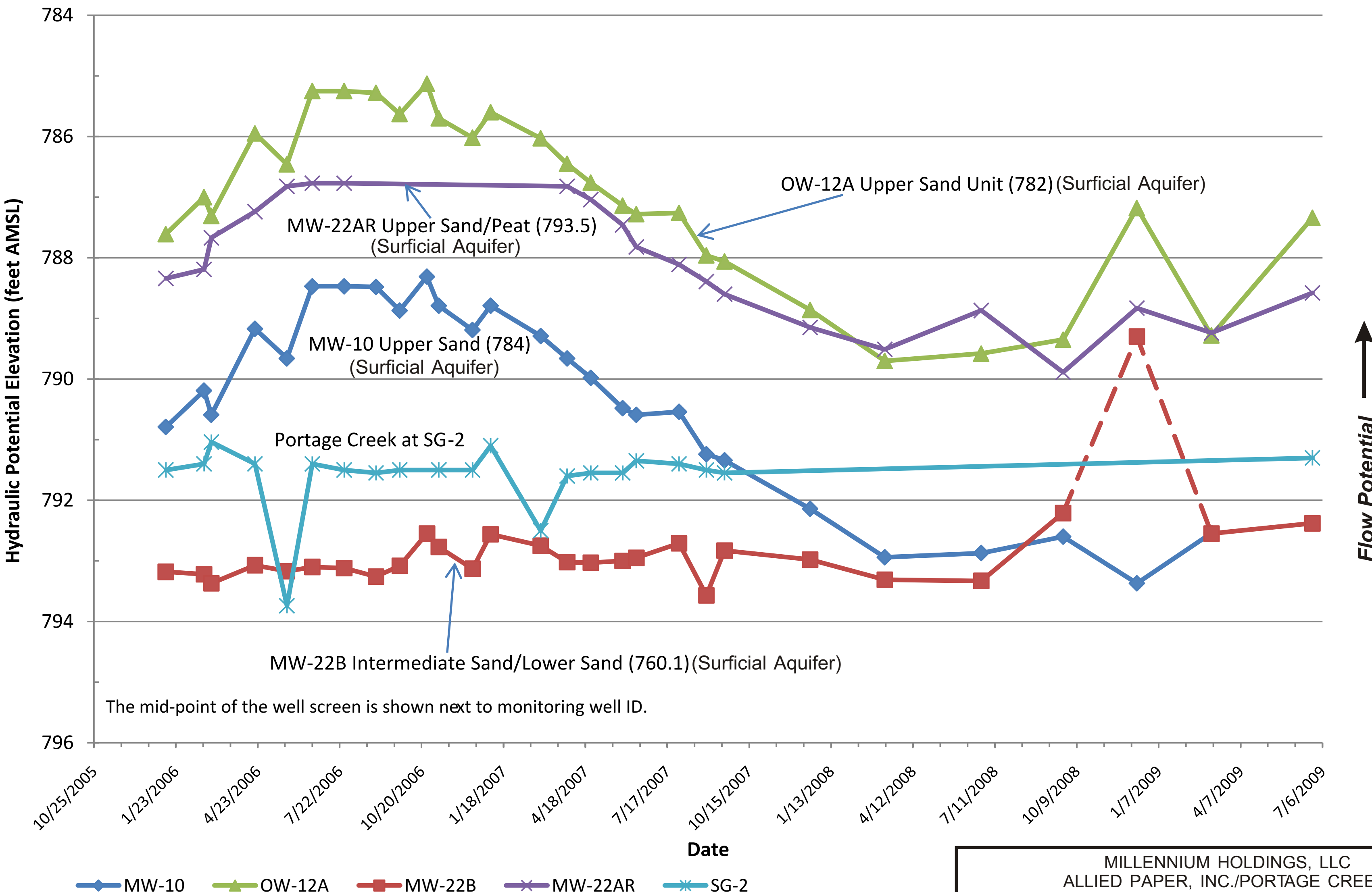
The data show a strong upward flow potential from the lower sand unit to the intermediate and upper sand units. Portage Creek is at the lowest elevation and serves as the discharge point for groundwater present in the upper, intermediate, and lower sand units.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALLIED OU - MW-204/OW-2 WELL CLUSTER GROUNDWATER ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-9



The data show an upward[1] flow potential from the intermediate/lower sand unit to the upper sand unit and Portage Creek. The lower groundwater elevations observed in the upper sand are due to the pumping of groundwater from behind the sheet pile wall from nearby extraction well GWE-4A.

NOTE:

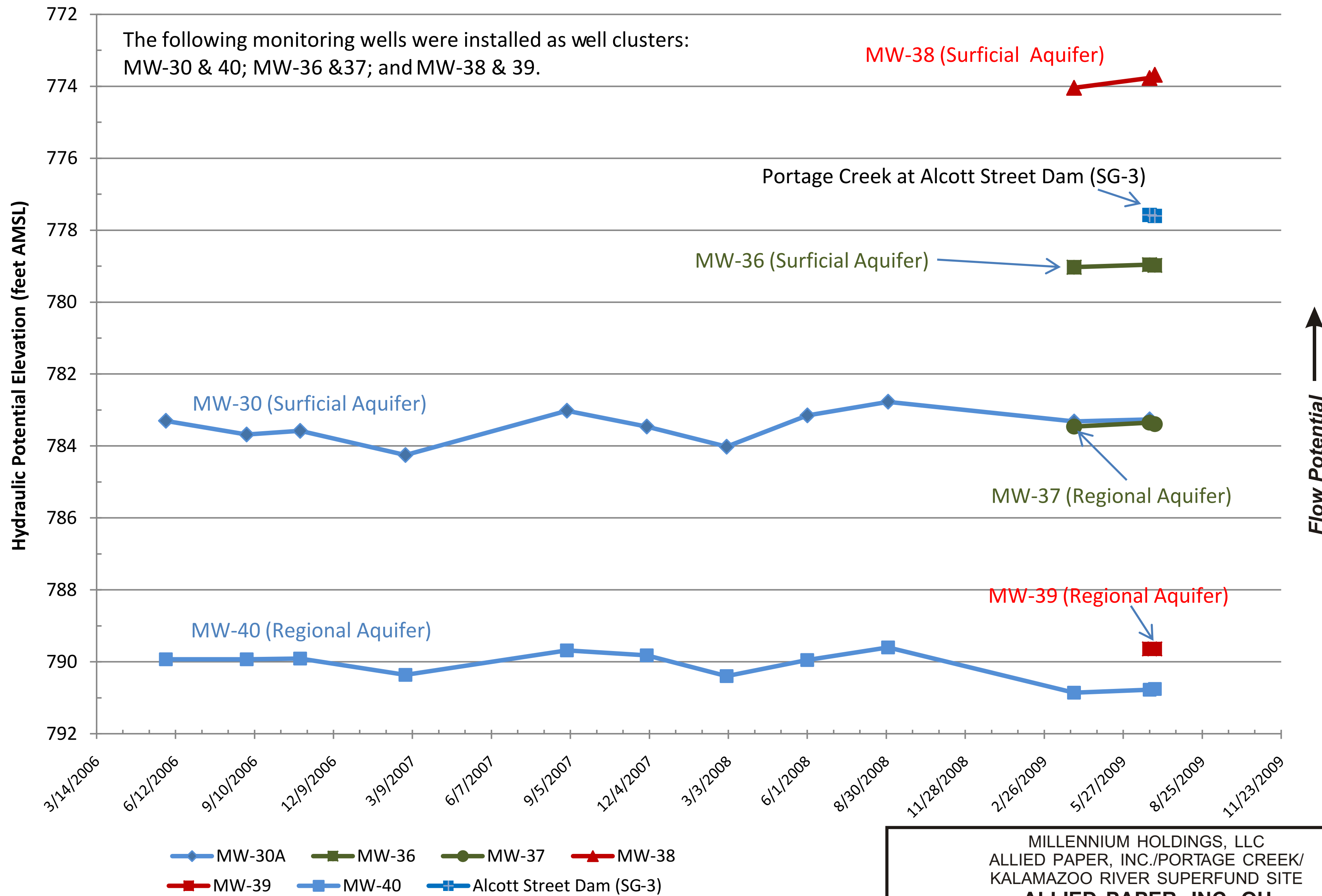
[1] The December 2008 elevation measurement at MW-22B is anomalous, varying by over 3.6 feet from the average of the elevations measured from 2006 to the present.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

ALLIED OU - MW-22/MW-10 WELL CLUSTER GROUNDWATER ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-10



Data for each well cluster, consisting of a well in the surficial aquifer and a well in the regional aquifer, show a strong upward flow potential between the two aquifer systems.

MILLENNIUM HOLDINGS, LLC
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
ALLIED PAPER, INC. OU

STREBOR PROPERTY MONITORING WELL CLUSTER GROUNDWATER ELEVATIONS 2006 - 2009

ARCADIS

FIGURE
3-11

ARCADIS

Attachment A

Historical Groundwater and
Surface Water Elevation Data

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL														
	1/12/2006	2/23/2006	3/3/2006	4/20/2006	5/25/2006	6/22/2006	7/27/2006	8/31/2006	9/26/2006	10/26/2006	11/8/2006	12/15/2006	1/4/2007	2/28/2007	3/29/2007
FW-101	796.56	796.64	796.56	796.35	796.31	795.63	795.44	795.75	796.19	796.70	796.75	800.36	796.76	796.65	796.61
GWE-1	788.05	788.17	788.27	788.27	788.54	788.41	788.36	788.53	788.31	788.32	788.43	788.56	788.57	788.42	788.67
GWE-1A	783.30	781.80	783.06	782.91	780.83	785.73	784.97	783.37	784.98	786.13	786.23	786.05	783.41	783.79	780.11
GWE-1P	788.07	788.14	788.28	788.29	788.35	788.40	788.37	788.27	788.29	788.29	788.42	788.55	788.57	788.40	788.65
GWE-4A	788.35	783.05	786.94	781.41	781.11	779.28	781.14	781.23	781.81	780.41	780.45	779.41	779.76	780.18	779.01
MW-5R	792.64	792.82	792.86	792.74	792.87	792.60	792.42	792.45	792.65	792.85	792.80	793.06	793.02	792.86	793.17
MW-6	797.74	797.85	797.90	797.86	798.02	797.79	797.67	797.78	797.80	797.96	797.74	798.21	798.05	797.97	798.28
MW-7	799.39	799.55	799.62	799.53	799.72	799.44	799.26	799.39	799.42	799.60	799.41	799.91	799.72	799.67	799.99
MW-8A	799.12	799.13	799.21	799.18	799.27	799.06	799.01	799.18	799.21	799.24	799.21	799.42	799.37	799.37	799.47
MW-16B	786.37	786.70	786.87	786.76	786.98	786.80	786.66	786.67	786.61	786.76	786.77	787.03	787.20	787.09	787.51
MW-19BR	794.96	795.39	795.69	795.59	795.78	795.55	795.18	794.99	795.20	795.43	795.50	795.93	796.04	795.79	796.27
MW-22AR	788.34	788.19	787.67	787.24	786.82	786.77	786.77	Dry	Dry	Dry	Dry	Dry	Dry	Dry	786.82
MW-22B	793.18	793.22	793.37	793.07	793.17	793.10	793.12	793.26	793.08	792.55	792.77	793.13	792.56	792.75	793.02
MW-23AR	795.71	795.74	795.81	795.78	795.90	795.81	795.81	795.89	795.86	795.67	795.70	795.93	795.87	795.94	796.07
MW-24R	788.53	788.47	788.39	788.33	788.39	788.32	788.40	788.43	788.41	788.39	788.50	788.58	788.50	788.49	789.17
MW-26	787.86	787.87	787.89	787.91	787.75	787.70	787.67	787.87	787.65	787.78	787.74	787.92	787.65	787.67	787.65
MW-120A	800.88	801.51	801.41	801.19	801.22	800.84	800.28	800.06	800.50	800.96	801.16	801.24	801.34	800.79	801.22
MW-120B	798.52	798.61	798.42	798.57	798.80	798.40	798.25	798.33	798.46	798.28	798.58	798.90	798.86	798.65	798.97
MW-122A	790.16	790.23	790.28	790.35	790.44	790.46	790.25	790.35	790.39	790.48	790.56	790.56	790.63	790.56	790.70
MW-122AR	790.78	790.84	790.91	791.00	791.10	791.10	791.08	790.98	791.00	791.06	791.15	791.17	791.22	791.15	791.29
MW-122B	789.55	789.66	789.73	789.68	789.83	790.26	790.28	790.15	790.13	790.18	790.22	790.40	790.39	790.38	790.53
MW-124A	808.32	809.11	810.52	810.85	810.94	812.46	812.12	811.55	811.87	811.74	811.73	812.17	812.42	813.42	813.61
MW-124B	801.88	802.09	802.63	802.69	802.87	802.78	802.71	802.71	802.62	802.55	802.65	803.08	802.61	802.92	803.25
MW-125A	792.60	792.61	792.32	792.36	792.48	791.73	791.70	791.44	792.27	792.83	792.44	793.53	792.42	793.32	792.83
MW-126A	796.26	796.57	796.47	796.35	796.28	795.93	795.78	795.99	795.11	794.70	795.96	796.07	795.55	795.59	795.86
MW-126AR	794.56	794.60	794.68	794.50	794.61	794.49	794.50	794.61	795.89	795.45	794.10	794.34	794.06	794.19	794.40
MW-200A	795.58	795.58	795.63	795.61	795.70	795.63	795.65	795.72	795.69	795.68	795.59	795.77	795.63	795.74	795.86
MW-201B	795.65	795.68	795.74	795.71	795.82	795.75	796.15	795.82	795.78	795.70	795.67	795.89	795.81	795.90	796.00
MW-202B	795.53	795.54	795.60	795.57	795.70	795.62	795.63	795.70	795.68	795.46	795.49	795.72	795.65	795.74	795.87
MW-203B	794.64	794.64	794.68	794.34	794.75	794.69	794.72	794.80	794.74	794.06	794.24	794.44	794.34	794.42	794.55
MW-204B	803.73	NM	803.90	804.39	804.59	804.50	804.43	804.42	804.42	804.29	804.33	804.48	804.54	804.74	802.95
MW-205B	792.19	792.41	792.66	792.65	792.92	792.74	792.54	792.49	792.56	792.62	792.70	793.03	793.01	792.97	793.28
MW-206A	796.08	796.10	796.16	796.78	796.24	796.15	796.14	796.20	796.19	796.15	796.11	796.34	796.28	796.30	796.43
MW-207	795.57	795.60	795.73	794.94	795.61	795.55	795.56	795.67	795.54	794.70	794.97	795.25	794.87	795.30	795.25
MW-208	795.86	795.93	796.13	795.79	795.84	795.81	795.84	796.00	795.74	795.54	795.72	796.12	795.32	795.55	795.84
MW-209	791.25	791.39	791.60	791.62	791.90	791.70	791.55	791.54	791.56	791.61	791.68	792.00	791.95	792.00	792.06
MW-210	794.92	794.92	795.02	794.86	795.00	794.92	794.92	795.02	794.93	793.84	794.13	794.40	794.13	794.30	794.45
MW-211	790.82	790.91	791.06	791.08	791.25	791.15	791.08	791.08	791.06	791.07	791.14	791.35	791.22	791.26	791.41
MW-212	787.01	787.13	787.19	787.13	787.27	787.67	787.60	787.60	787.41	787.58	787.62	787.81	787.80	787.81	787.93
MW-213	790.57	790.66	790.80	790.83	790.98	790.89	790.85	790.88	790.85	790.86	790.93	791.11	790.96	791.02	791.05
MW-214	787.47	787.45	787.52	787.48	787.53	787.19	787.14	787.40	787.45	787.51	787.53	787.69	788.17	787.71	787.76
MW-215	783.42	783.10	783.38	782.88	782.86	782.67	782.59	783.16	783.14	783.33	783.37	783.34	783.34	783.41	783.24
MW-216	781.82	781.85	781.90	781.83	781.96	782.14	782.31	782.36	782.15	782.04	781.96	782.02	782.02	781.92	782.03
MW-217	782.57	782.59	782.61	782.55	782.71	782.86	782.94	782.96	782.76	782.72	782.64	782.78	782.77	782.72	782.82
MW-218	785.20	785.41	785.41	785.35	785.48	785.50	785.44	785.44	785.30	785.32	785.30	785.52	785.55	NM	785.69

See Notes on Page 4.

Millennium Holdings, LLC
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Allied Paper, Inc. Operable Unit
Supplemental Groundwater Investigation Report

Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL														
	1/12/2006	2/23/2006	3/3/2006	4/20/2006	5/25/2006	6/22/2006	7/27/2006	8/31/2006	9/26/2006	10/26/2006	11/8/2006	12/15/2006	1/4/2007	2/28/2007	3/29/2007
MW-219	784.00	784.07	784.12	784.06	784.18	784.29	784.30	784.34	784.14	784.64	784.10	784.28	784.29	784.81	784.48
MW-220	784.13	785.05	785.13	784.55	784.94	784.88	783.46	783.62	784.11	784.64	784.50	785.39	785.16	784.35	785.18
MW-221R	782.08	782.06	782.00	781.93	782.00	782.02	782.14	782.31	782.16	782.14	782.22	782.19	782.19	782.13	782.21
MW-222	794.23	NM	794.24	794.18	794.33	794.27	794.31	794.38	794.32	793.07	793.36	793.55	793.43	793.32	793.64
MW-223	794.04	793.82	793.90	792.45	792.63	792.73	792.90	793.15	793.10	792.95	793.11	793.51	793.06	NM	NM
MW-224	790.79	792.20	791.45	791.20	792.03	790.48	790.02	790.00	790.47	791.57	791.80	792.72	792.13	790.62	792.36
MW-225	786.08	786.16	786.12	786.04	786.36	785.92	785.86	785.89	786.16	786.40	786.12	786.95	786.57	NM	NM
MW-226	783.59	783.44	783.59	783.58	783.55	783.49	783.50	783.49	783.48	783.57	783.62	783.56	783.59	783.18	783.40
MW-227	782.26	781.84	781.72	781.34	781.61	obstructed	780.65	782.01	781.98	782.23	782.13	782.16	782.08	782.39	781.89
MW-228	783.34	783.23	783.20	782.98	782.99	783.10	782.81	783.16	783.11	783.31	783.37	783.35	783.39	783.40	783.15
MW-229	783.89	783.62	783.72	783.46	783.27	783.03	783.00	783.68	783.65	785.63	783.77	783.78	783.75	783.90	783.63
MW-230	785.52	785.68	785.39	785.14	785.45	784.80	783.97	785.13	785.26	785.59	785.36	785.95	785.56	785.30	785.61
MW-231	786.33	786.54	785.97	786.29	786.39	786.41	786.51	786.57	786.49	786.46	786.36	786.26	786.46	790.66	785.06
MW-232	782.75	782.85	782.87	782.79	782.90	782.80	782.99	783.12	782.92	782.87	782.83	782.99	783.02	782.99	783.15
OW-1A	784.65	784.77	784.92	784.86	785.03	785.26	785.20	785.11	785.13	785.15	785.24	785.91	785.43	785.38	785.58
OW-2A	786.97	786.92	786.97	786.90	787.00	786.86	786.89	786.90	786.96	786.93	787.06	787.08	787.06	787.01	787.03
OW-2B	788.75	788.85	788.01	789.01	789.17	789.04	788.99	788.99	789.00	789.00	789.12	789.32	789.24	789.25	789.40
OW-2P	786.83	786.98	786.90	786.88	786.92	786.90	786.86	786.89	786.93	786.91	786.97	787.03	786.97	786.91	786.91
OW-3AR	787.96	787.95	787.96	787.86	787.93	787.81	787.94	787.96	787.91	787.94	788.05	788.21	787.95	788.54	787.87
OW-3PR	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
OW-4AR	Obstructed	NM	NM	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
OW-4PR	797.30	797.40	797.43	obstructed	797.45	797.47	797.46	797.39	797.81	797.14	797.29	797.20	797.34	797.27	797.31
OW-5P	796.52	797.19	797.14	796.77	797.49	796.97	796.49	796.33	796.82	797.18	797.21	797.53	797.29	796.62	797.33
OW-6A	795.76	795.78	795.82	795.82	795.91	795.82	795.82	795.87	795.85	795.80	795.77	795.29	795.87	795.97	796.12
OW-6P	798.31	799.07	798.85	798.70	799.87	798.67	797.48	797.17	798.74	799.74	799.45	800.20	799.85	798.80	800.44
OW-7P (OW-7PR)	788.73	788.82	788.92	789.00	789.10	789.11	789.11	789.01	789.03	789.00	789.11	789.13	789.16	789.04	789.19
OW-8A	782.81	782.11	783.28	782.74	783.42	785.46	784.94	783.96	784.80	785.71	785.94	785.64	784.18	785.06	785.69
OW-9PR	792.54	792.48	792.45	792.45	792.55	792.54	792.58	792.61	792.66	792.62	792.67	792.65	792.62	792.49	792.50
OW-10P	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
OW-11A	788.52	788.66	788.71	788.66	788.71	788.63	788.58	788.56	788.59	788.61	788.71	788.76	788.79	788.76	788.84
OW-11P	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
OW-12A	787.61	787.00	787.31	785.95	786.46	785.25	785.25	785.28	785.63	785.13	785.70	786.02	785.60	786.03	786.45
OW-13A	785.72	785.81	785.65	785.83	785.83	785.51	785.50	785.55	785.86	789.42	785.72	785.80	785.77	785.67	785.72
OW-13B	NM	NM	NM	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
OW-13P	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	obstructed
OW-14P	790.06	790.10	790.11	790.04	790.13	790.07	790.13	790.20	790.20	790.19	790.21	790.22	790.10	790.76	790.11
OW-15P	796.33	796.48	796.25	796.00	796.65	795.98	795.71	795.84	796.31	796.65	796.16	797.04	796.40	795.97	796.77
OW-16P	792.40	792.54	792.15	791.89	791.89	791.81	791.61	791.59	791.71	791.56	791.52	791.81	791.48	791.96	792.18
OW-17P	789.19	789.03	789.24	789.22	789.23	789.24	789.24	789.31	789.33	789.34	789.41	789.46	789.36	789.26	789.28
PS-1	786.34	785.99	786.01	785.68	785.76	785.97	786.08	786.01	786.02	785.74	786.02	786.01	785.72	785.83	786.05
PS-2	786.95	786.43	786.60	786.78	786.96	786.81	786.54	786.98	786.49	786.84	786.79	786.56	786.66	786.91	786.59
PS-3	786.07	786.38	786.36	786.39	786.19	786.27	786.21	786.36	786.21	786.36	786.30	786.26	786.22	785.74	786.34
PS-4	786.97	787.34	786.97	787.03	786.96	786.59	786.64	787.31	786.54	787.32	787.14	787.32	787.09	789.54	786.75
PS-5	794.65	794.47	793.78	794.47	794.47	793.93	794.22	794.69	793.91	794.25	794.63	793.72	794.56	793.78	794.70
PS-6	791.05	791.06	791.06	790.52	790.50	790.05	789.73	789.81	790.21	789.91	789.95	790.38	789.81	790.66	790.79
PS-7	789.89	790.06	789.88	790.24	790.14	789.83	789.81	789.87	790.21	794.54	790.04	790.12	790.12	789.94	790.03
PS-8	790.69	790.81	790.74	790.93	790.91	790.76	790.93	790.91	790.91	790.45	790.84	790.93	790.92	790.80	791.07
PS-9	790.10	790.11	789.79	789.79	789.67	790.06	790.04	790.06	790.04	790.02	789.71	789.67	789.92	789.84	790.06
PS-10	792.44	792.65	792.67	792.35	792.67	792.45	792.57	792.49	792.48	792.45	792.57	792.45	792.43	792.45	791.75
SG-1	782.13	782.08	782.04	782.00	782.04	782.08	782.16	782.38	782.20	782.18	782.32	782.26	782.24	782.14	782.26
SG-2	791.50	791.40	791.04	791.40	793.74	791.40	791.50	791.55	791.50	NM	791.50	791.50	791.10	792.50	791.60

See Notes on Page 4.

Millennium Holdings, LLC
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Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL												
	4/24/2007	5/29/2007	6/13/2007	7/30/2007	8/29/2007	9/18/2007	12/21/2007	3/12/2008	6/26/2008	9/24/2008	12/14/2008	3/6/2009	6/25-6/26/09
FW-101	796.63	795.99	795.36	794.96	795.86	795.39	796.67	796.78	795.65	796.10	796.74	796.73	795.70
GWE-1	788.71	788.59	788.50	788.28	788.33	788.35	783.27	788.70	788.57	788.46	788.39	788.86	783.26
GWE-1A	786.11	782.93	786.13	785.70	785.53	785.63	785.38	781.25	785.93	785.36	785.53	785.53	787.95
GWE-1P	788.67	808.60	808.60	808.60	808.60	808.60	808.60	808.60	808.60	808.60	803.20	803.20	797.53
GWE-4A	781.26	780.34	782.24	778.41	778.99	779.63	776.16	779.96	794.21	792.12	789.41	792.34	782.62
MW-5R	793.12	792.88	792.77	792.43	792.72	792.49	792.74	793.23	792.89	793.27	792.94	793.39	793.10
MW-6	798.25	798.18	798.06	797.65	798.00	797.67	797.73	798.25	798.22	798.75	798.17	798.55	798.61
MW-7	800.46	799.81	799.68	799.24	799.67	799.25	799.33	799.99	799.84	800.68	799.83	800.30	800.30
MW-8A	799.44	799.39	799.21	798.84	799.29	799.02	799.23	799.52	799.40	799.49	799.42	799.64	799.54
MW-16B	787.36	787.29	787.13	786.77	786.88	786.64	786.43	787.35	787.27	787.74	787.16	787.25	787.61
MW-19BR	796.33	796.06	795.90	795.26	795.29	795.14	795.18	796.41	795.08	796.51	796.44	796.69	797.49
MW-22AR	787.04	787.46	787.82	788.11	788.39	788.60	789.15	789.51	788.87	789.89	788.83	789.24	788.58
MW-22B	793.03	793.00	792.95	792.71	793.57	792.83	792.98	793.31	793.33	792.21	789.30	792.55	792.38
MW-23AR	796.02	796.00	795.91	795.69	795.91	795.78	795.86	796.15	796.12	796.17	796.02	796.20	793.65
MW-24R	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
MW-26	787.60	787.63	787.57	787.47	787.68	787.64	787.78	787.69	787.59	787.60	787.79	787.68	787.58
MW-120A	801.34	800.97	800.72	799.96	799.99	800.28	800.84	801.68	800.90	800.86	800.78	801.48	801.06
MW-120B	798.94	798.80	798.62	798.13	798.62	798.30	798.53	799.13	798.92	799.43	798.84	799.31	799.06
MW-122A	790.72	790.68	790.59	790.43	790.59	790.50	790.40	790.73	790.74	790.76	790.65	790.77	790.82
MW-122AR	791.34	791.29	791.18	791.02	791.10	791.03	790.98	791.32	791.35	791.25	791.23	791.43	791.38
MW-122B	790.55	790.40	790.35	790.16	790.66	790.11	790.09	790.55	790.45	790.58	790.46	790.78	791.03
MW-124A	813.78	813.49	813.11	812.82	812.75	812.41	809.75	812.29	813.89	814.78	812.45	814.07	814.62
MW-124B	803.30	803.23	803.08	802.24	802.56	802.41	802.41	803.15	803.33	803.28	803.04	803.73	803.68
MW-125A	792.73	792.53	792.27	791.25	792.62	791.64	792.27	792.53	792.81	792.70	792.75	793.15	793.06
MW-126A	795.78	795.58	795.49	795.28	795.76	795.61	796.47	796.46	796.05	796.00	795.58	795.78	795.57
MW-126AR	794.35	794.30	794.32	794.04	794.27	794.15	794.32	794.57	794.52	793.99	793.98	794.24	794.09
MW-200A	795.78	795.78	795.68	795.38	795.67	795.48	795.58	795.78	795.76	795.35	795.46	795.66	795.52
MW-201B	795.93	795.92	795.82	795.60	795.80	795.67	795.77	796.05	796.00	796.02	795.83	795.99	795.89
MW-202B	795.80	795.90	795.72	795.53	795.73	795.61	795.67	795.95	796.00	796.07	795.86	796.03	792.19
MW-203B	794.52	794.51	794.44	794.30	794.51	794.42	794.40	794.65	794.67	794.71	794.52	794.64	790.38
MW-204B	805.31	805.22	805.03	804.14	804.57	804.39	804.35	DRY	805.23	805.27	805.15	802.25	805.86
MW-205B	793.36	793.23	793.09	792.56	792.71	792.51	792.47	793.27	793.29	793.45	793.15	793.70	793.70
MW-206A	796.37	796.27	796.25	795.99	796.20	796.06	796.14	796.45	796.40	796.11	796.13	796.37	796.25
MW-207	795.27	795.24	795.20	794.98	795.20	795.13	795.18	795.51	795.53	794.74	794.79	795.02	794.90
MW-208	795.86	795.82	795.80	795.52	795.72	796.13	795.80	796.14	796.13	794.48	794.65	794.95	790.70
MW-209	792.06	792.04	791.90	791.55	791.74	791.56	791.54	792.12	792.08	792.28	NM	overflowing	NA
MW-210	794.46	794.43	794.38	794.25	794.47	794.37	794.40	794.67	794.69	794.74	794.30	794.48	794.39
MW-211	791.44	791.43	791.31	791.03	791.25	791.10	791.09	791.49	791.53	791.60	791.57	791.79	791.74
MW-212	787.87	787.79	787.67	787.57	787.63	787.50	787.47	787.96	787.83	787.91	787.84	787.81	788.31
MW-213	791.18	791.14	791.03	790.80	791.01	790.88	790.87	791.19	791.17	791.20	NM	791.48	791.53
MW-214	787.66	787.41	787.24	787.31	787.11	787.16	787.51	787.74	787.37	787.52	787.73	787.82	787.63
MW-215	782.95	783.03	782.38	782.08	780.86	782.86	783.33	783.29	782.59	783.09	783.41	783.51	782.66
MW-216	781.97	782.06	782.17	782.30	782.37	782.19	781.89	782.05	782.49	782.30	782.15	782.12	782.19
MW-217	782.72	783.31	782.92	782.93	782.96	782.82	782.57	782.77	783.08	782.92	782.81	782.91	782.91
MW-218	785.65	785.62	785.62	785.44	785.47	785.31	784.95	785.39	785.56	785.45	785.44	785.51	785.71

See Notes on Page 4.

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Table A-1 -- Allied OU - Historical Groundwater and Portage Creek Elevation Monitoring Data, 2006 - 2009

Location	Groundwater Elevation in feet AMSL												
	4/24/2007	5/29/2007	6/13/2007	7/30/2007	8/29/2007	9/18/2007	12/21/2007	3/12/2008	6/26/2008	9/24/2008	12/14/2008	3/6/2009	6/25-6/26/09
MW-219	784.42	784.46	784.51	784.42	784.44	784.27	783.52	783.92	784.32	784.16	784.13	784.37	784.49
MW-220	785.08	784.46	784.02	783.10	783.94	783.83	783.96	785.17	784.61	785.91	784.14	785.27	784.15
MW-221R	782.08	782.08	782.05	782.27	782.34	782.23	782.01	782.13	782.19	782.28	782.25	782.12	782.08
MW-222	793.63	794.07	793.54	793.45	793.65	793.58	793.57	793.00	793.74	793.51	793.44	793.58	793.54
MW-223	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	792.75
MW-224	792.02	790.75	790.46	790.01	790.38	790.18	791.14	791.67	790.54	792.01	790.70	792.45	790.89
MW-225	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	787.34
MW-226	783.50	783.48	783.37	783.25	783.66	783.48	783.67	783.64	783.59	783.61	783.75	783.67	783.46
MW-227	781.30	781.91	780.84	NM	781.59	NM	782.23	782.37	NM	781.79	782.59	782.38	781.55
MW-228	783.04	783.05	782.79	782.71	782.94	782.80	783.35	783.30	782.85	783.23	783.56	783.50	782.91
MW-229	783.41	783.61	782.78	NM	783.37	782.69	783.83	783.86	782.88	783.49	784.01	783.82	783.24
MW-230	785.48	785.46	784.39	783.55	785.54	784.66	785.30	785.58	784.77	785.57	785.67	785.68	785.12
MW-231	786.46	786.45	786.48	786.53	786.72	786.53	obstructed	obstructed	786.76	786.73	NM	784.64	786.68
MW-232	783.07	783.03	783.00	783.14	783.19	783.05	782.72	783.09	783.17	783.38	783.14	783.28	783.16
OW-1A	785.60	785.48	785.39	785.16	785.26	785.09	785.03	785.60	785.53	785.60	785.45	785.86	785.98
OW-2A	787.06	787.01	786.98	787.04	787.04	787.02	787.02	787.17	787.16	787.21	787.19	787.31	787.18
OW-2B	789.47	789.40	789.31	789.01	789.18	789.07	789.05	789.45	789.57	789.62	789.55	789.82	789.76
OW-2P	786.98	786.95	786.94	787.00	786.99	786.99	786.91	787.05	787.07	787.12	787.04	787.15	787.06
OW-3AR	788.77	787.81	787.85	787.88	787.99	788.01	788.12	788.03	788.01	787.92	790.01	787.93	787.72
OW-3PR	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	obstructed	obstructed
OW-4AR	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	791.96	792.74	792.28	792.70	obstructed	792.42	dry/damaged
OW-4PR	797.31	797.35	797.39	797.39	797.34	797.30	797.01	797.24	794.33	794.18	793.76	794.04	797.14
OW-5P	797.33	796.97	796.79	796.08	796.64	796.72	797.23	798.32	797.36	797.41	796.90	798.14	dry/damaged
OW-6A	796.05	796.05	795.94	795.70	795.89	795.75	796.30	796.63	796.56	796.76	796.35	796.52	796.42
OW-6P	800.55	799.62	798.81	797.20	798.22	797.96	799.42	800.37	798.53	798.53	798.67	800.77	799.29
OW-7P (OW-7PR)	789.35	789.39	789.37	789.10	789.07	789.04	788.44	789.27	789.54	789.27	789.22	789.64	789.76
OW-8A	785.09	783.91	785.73	784.94	obstructed	obstructed	obstructed	obstructed	NM	NM	obstructed	obstructed	obstructed
OW-9PR	792.53	792.65	792.57	792.60	792.64	792.66	792.65	792.58	792.62	792.67	792.64	792.58	792.65
OW-10P	dry	dry	dry	dry	dry	dry	obstructed	obstructed	NM	NM	obstructed	obstructed	obstructed
OW-11A	788.82	788.72	788.68	789.02	788.68	788.59	788.59	788.87	788.72	788.79	788.71	788.99	788.98
OW-11P	dry	dry	dry	dry	dry	dry	obstructed	obstructed	NM	NM	786.97	obstructed	obstructed
OW-12A	786.76	787.14	787.28	787.26	787.96	788.06	788.86	789.70	789.58	789.35	787.18	789.28	787.34
OW-13A	785.72	785.86	785.80	785.72	785.95	785.96	786.04	786.05	786.01	786.19	785.99	786.15	785.92
OW-13B	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	793.55	obstructed	obstructed
OW-13P	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed	obstructed
OW-14P	790.95	790.14	790.18	790.21	790.33	790.32	790.31	790.23	790.41	790.38	790.25	790.23	790.26
OW-15P	796.48	796.01	795.95	795.28	796.60	795.75	796.23	796.84	796.14	796.18	796.19	797.00	796.29
OW-16P	792.30	792.36	792.47	792.38	792.53	792.66	793.11	793.74	792.59	793.52	792.25	789.29	792.65
OW-17P	789.35	789.31	789.34	789.38	789.43	789.41	789.34	789.46	789.47	789.96	789.46	789.58	789.38
PS-1	785.93	785.85	786.00	785.87	786.00	786.00	785.98	785.73	786.09	785.99	786.00	786.11	NM
PS-2	786.67	786.38	786.78	788.10	786.81	786.81	786.89	786.66	786.76	786.53	786.24	786.54	NM
PS-3	786.25	785.21	786.42	785.91	786.35	786.23	786.40	786.23	785.86	786.33	785.79	786.36	NM
PS-4	790.14	786.76	786.96	786.69	786.93	787.07	786.79	786.89	786.97	786.91	786.72	786.59	NM
PS-5	793.91	794.46	794.57	794.13	794.09	794.00	794.20	796.90	796.26	793.81	794.20	794.53	NM
PS-6	790.86	791.24	790.94	791.13	790.66	791.04	790.86	791.16	790.77	791.03	791.09	793.73	NM
PS-7	790.04	790.17	790.07	789.99	790.19	790.19	790.15	790.17	790.18	790.23	790.16	790.33	NM
PS-8	790.82	790.85	790.90	790.95	790.76	790.96	790.70	790.96	790.92	790.97	790.85	790.88	NM
PS-9	790.10	789.71	789.74	789.70	789.87	789.94	789.73	789.91	789.76	789.86	789.94	789.64	NM
PS-10	792.50	792.13	792.45	792.55	792.45	792.62	792.55	792.73	792.73	792.93	791.85	792.25	NM
SG-1	782.10	782.15	782.10	782.29	782.38	782.32	NM	NM	NM	NM	NM	NM	781.92
SG-2	791.55	791.55	791.35	791.40	791.50	791.55	NM	NM	NM	NM	NM	NM	791.30

Notes:
NM = not measured.
feet AMSL = feet above mean sea level.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
Groundwater level for MW-209 was at the top of casing.

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Table A-2 -- Strebor Property - Historical Groundwater Elevation Monitoring Data

Well Number	Top of Casing Elevation (feet AMSL)[1]	3/1/2004[2]		6/1/2004[2]		9/1/2004[2]		3/1/2005[2]		6/1/2005[2]		9/1/2005[2]		3/1/2006[2]	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
MW-1	802.79	NM		NM		NM		NM		NM		NM		NM	
MW-7	795.28	NM		NM		NM		NM		NM		NM		NM	
MW-15	797.23	NM		NM		NM		NM		NM		NM		NM	
MW-21	794.63	NM		NM		NM		NM		NM		NM		NM	
MW-24	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-25	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-30A	796.32	12.94	783.38	12.74	783.58	13.06	783.26	11.30	785.02	12.44	783.88	13.51	782.81	12.52	0.22
MW-35	794.88	NM		NM		NM		NM		NM		NM		NM	
MW-36	788.55	NM		NM		NM		NM		NM		NM		NM	
MW-37	788.28	NM		NM		NM		NM		NM		NM		NM	
MW-38	781.5	NM		NM		NM		NM		NM		NM		NM	
MW-39	781.55	NM		NM		NM		NM		NM		NM		NM	
MW-40	796.51	6.82	789.69	6.56	789.95	NM		5.94	790.57	5.95	790.56	6.61	789.9	6.61	789.9

Well Number	Top of Casing Elevation (feet AMSL)[1]	6/1/2006[2]		9/1/2006[2]		12/1/2006[2]		3/1/2007[2]		9/1/2007[2]		12/1/2007[2]		3/1/2008[2]	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
MW-1	802.79	NM		NM		NM		NM		NM		NM		NM	
MW-7	795.28	NM		NM		NM		NM		NM		NM		NM	
MW-15	797.23	NM		NM		NM		NM		NM		NM		NM	
MW-21	794.63	NM		NM		NM		NM		NM		NM		NM	
MW-24	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-25	795.04	NM		NM		NM		NM		NM		NM		NM	
MW-30A	796.32	13.02	783.3	12.64	783.68	12.74	783.58	12.07	784.25	13.3	783.02	12.86	783.46	12.3	784.02
MW-35	794.88	NM		NM		NM		NM		NM		NM		NM	
MW-36	788.55	NM		NM		NM		NM		NM		NM		NM	
MW-37	788.28	NM		NM		NM		NM		NM		NM		NM	
MW-38	781.5	NM		NM		NM		NM		NM		NM		NM	
MW-39	781.55	NM		NM		NM		NM		NM		NM		NM	
MW-40	796.51	6.58	789.93	6.58	789.93	6.6	789.91	6.15	790.36	6.83	789.68	6.69	789.82	6.11	790.4

Well Number	Top of Casing Elevation (feet AMSL)[1]	6/1/2008[2]		9/1/2008[2]		March 23 - April 1, 2009[2]	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
MW-1	802.79	NM		NM		10.05	792.74
MW-7	795.28	NM		NM		8.06	787.22
MW-15	797.23	NM		NM		9.25	787.98
MW-21	794.63	NM		NM		9.84	784.79
MW-24	795.04	NM		NM		9.68	785.36
MW-25	795.04	NM		NM		7.87	787.17
MW-30A	796.32	13.17	783.15	13.55	782.77	NM	
MW-35	794.88	NM		NM		8.89	785.99
MW-36	788.55	NM		NM		9.52	779.03
MW-37*	788.28	NM		NM		4.82	783.46
MW-38	781.5	NM		NM		7.46	774.04
MW-39*	781.55	NM		NM		NM	
MW-40*	796.51	6.56	789.95	6.91	789.6	5.65	790.86

See Notes on Page 2.

Table A-2 -- Strebor Property - Historical Groundwater Elevation Monitoring Data

Notes:
ft = feet
AMSL = above mean sea level.
Quarterly depth to water measurements were provided by Bay West on April 7, 2009. The exact dates when measurements were collected during the quarter were not included in the data transmission, so it was assumed that the measurements were collected on the first day of each quarter.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
[1] Surveyed by Prein & Newhof in 2009.
[2] Measurements were made by Bay West personnel.
NM = not measured.
TOC = Top of casing
* MW-37, MW-39, and MW-40 are screened in the Regional Aquifer Unit, the other wells are screened in the Surfical Aquifer Unit.

Table A-3 -- Panelyte Property - Historical Groundwater Elevation Monitoring Data

Well Number	Aquifer Unit	June 24, 2002		October 20, 2003	
		Depth to Water (ft below TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft below TOC)	Groundwater Elevation (feet AMSL)
MW1	Surficial	8.47	788.69	8.54	788.62
MW2	Surficial	8.80	787.18	9.06	786.92
MW3	Surficial	6.19	793.25	NM	NM
MW4	Surficial	6.84	788.49	6.84	788.49
MW5	Surficial	7.08	787.97	6.90	788.15
MW6	Surficial	7.22	785.48	7.09	785.61
MW7	Surficial	8.53	786.87	8.70	786.70
MW8	Surficial	6.76	789.14	6.59	789.31
MW9	Surficial	0.46	780.65	1.32	779.79
MW10	Surficial	-0.3*	781.86	-0.6*	782.16
MW11	Surficial	1.57	781.38	2.17	780.78

Notes:
ft = feet
AMSL = above mean sea level.
Well construction information and 2002 and 2003 groundwater elevation data are from the Preliminary Site Assessment Report, Former Panelyte Site, Kalamazoo Michigan, Malcolm Pirnie, December 8, 2004.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
* - Static water level was above top of casing. Value is approximate.
NM = not measured.
TOC = Top of casing
Aquifer Unit designations are based on aquifer designations in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.

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Table A-4 Performance Paper Property - Historical Groundwater Elevation Monitoring Data

Well Number	Aquifer Unit	9/21/2005		6/8/2006	
		Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)	Depth to Water (ft from TOC)	Groundwater Elevation (feet AMSL)
ATL-03	Surficial	NA	NA	NA	NA
ATL-04	Surficial	20.24	760.03	18.18	762.09
ATL-05	Surficial	10.08	763.34	9.20	764.22
MW2-02	Surficial	18.25	765.15	17.37	766.03
MW-3	Surficial	NA	NA	NA	NA
MW3-01	Surficial	14.38	763.06	NA	NA
MW3-02	Surficial	14.81	763.00	13.55	764.26
MW3-04	Surficial	NA	NA	NA	NA
MW-4	Surficial	NA	NA	NA	NA
MW-5	Surficial	NA	NA	NA	NA
MW-6	Surficial	NA	NA	NA	NA
MW-7	Surficial	NA	NA	NA	NA
MW-9	Surficial	17.02	770.62	16.86	770.78
MW-10D	Surficial	12.29	769.23	11.76	769.76
MW-10S	Surficial	13.87	766.86	13.41	767.32
MW-11	Surficial	8.51	770.45	7.56	771.40
MW-12D	Surficial	5.50	766.15	5.16	766.49
MW-12S	Surficial	6.06	765.35	4.64	766.77
MW-13	Surficial	23.10	765.30	22.03	766.37
MW-14	Surficial	7.55	760.21	6.48	761.28
MW-15D	Surficial	18.46	761.33	NA	NA
MW-15S	Surficial	18.80	760.92	NA	NA
MW-16D	Surficial	16.88	760.48	15.37	761.99
MW-16S	Surficial	16.47	760.47	15.82	761.12
MWB-02	Surficial	NA	NA	NA	NA
MWB-03	Surficial	NA	NA	NA	NA
MWLTI	Surficial	16.72	NA	15.68	NA
PW-1	Surficial	22.19	767.28	21.38	768.09
PW-2	Surficial	20.57	765.61	20.10	766.08
PW-3	Surficial	12.22	766.00	12.09	766.13
PW-4	Surficial	10.78	764.85	9.57	766.06
PW-5	Surficial	10.45	764.59	9.67	765.37
PW-6	Surficial	10.71	763.53	8.72	765.52

Notes:
ft = feet
AMSL = above mean sea level.
NA = not available.
Elevations are based on the existing Allied OU site control, which is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.
TOC = Top of casing
Aquifer Unit designations are based on aquifer designations in Figure 2 from the April 30, 2008 MDEQ Memorandum from Brant Fisher to Paul Bucholtz.

Appendix B
PRG Technical Memorandum

Summarization of Preliminary Remedial Goals Kalamazoo River/Portage Creek OU1 Site WA No. 037-RSBD-059B, Contract EP-S5-06-01

PREPARED FOR: Michael Berkoff / USEPA

PREPARED BY: CH2M HILL

DATE: March 10, 2009

This Technical Memorandum (TM) is prepared for the U. S. Environmental Protection Agency (U.S. EPA) to develop a list of preliminary remedial goals (PRGs) for the Allied Paper Landfill (OU1) of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site for use during remedial alternative evaluation in the Feasibility Study (FS). This TM provides a qualitative assessment of the exposure pathways, receptors and land use scenarios at OU1 for consideration of PRGs for the various site media. This summary of PRGs will be compared to site-specific data and utilized during the development of an array of potential remedial alternatives in the FS to be prepared by Millennium Holdings. Further, this document will assist U.S. EPA in the evaluation of remedial alternatives presented in the FS and in the development of the ROD.

Early investigative efforts recognized that if the extent of polychlorinated biphenyls (PCBs) in OU1 was identified and appropriately remediated, then other associated hazardous substances would also be addressed (CDM, 2008). This TM is focused on PCBs as the driver for evaluating risk. Other potential contaminants of concern have been identified at OU1 and will need to be considered with PCBs for future remedial actions.

The Michigan Department of Environmental Quality (MDEQ) completed a *Site-wide Final (Revised) Human Health Risk Assessment* (CDM, 2003a) and *Final (Revised) Baseline Ecological Risk Assessment* (CDM, 2003b) for the entire Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. The Human Health Risk Assessment (HHRA) quantitatively assessed potential risks to human health through exposure to media impacted with PCBs, including the consumption of fish, direct contact with contaminated floodplain soils, and inhalation of dust and volatile emissions from floodplain soils. The Baseline Ecological Risk Assessment (BERA) quantitatively assessed potential risks to various ecological receptors for different exposure pathways. U.S. EPA has determined that risk to human and ecological receptors exists at the Site based on the results of the HHRA and BERA. A feasibility study is necessary to evaluate alternatives to mitigate the risks.

Risk-based levels from the HHRA and BERA were compiled with other established risk-based levels and regulatory criteria in the performance of this evaluation. Although the BERA is currently under peer review, the document was used in preparation of this evaluation and consideration of risk-based PRGs. In addition to the quantitative PRGs identified, a qualitative PRG is also recommended that requires either remedial actions where residuals are visually observed or sufficient sampling to verify the residuals do not contain PCB concentrations above the applicable goals.

Conceptual Site Model

To assist with the identification of PRGs, a conceptual site model (CSM) was developed to identify sources, release mechanisms, media, exposure routes, and receptors that may be present at the site. The CSM considers exposures that may occur with residential, recreational, commercial and industrial land uses. Figure 1 presents the CSM based on human receptors. This CSM was developed based on the *Risk Assessment Guidance for Superfund* (U.S. EPA, 1998).

Figure 2 is a modified CSM to consider ecological receptors, but was limited to defining the receptors as terrestrial or aquatic-based receptors. The BERA identified the most sensitive terrestrial receptor as the robin and the most sensitive aquatic receptor as the mink. The risk-based criteria developed based on the robin and mink will be used in later evaluations.

The CSM was prepared to be inclusive of the potential scenarios that may be present in OU1. However, different media and land uses are present throughout the site. Therefore, to evaluate the risks which may be present in the different areas, OU1 was separated into four areas as shown in Figure 3. These areas are consistent with the presentation of investigation data in the RI Report (CDM, 2008) and are identified below with a description of the media present within that area:

- **Former Bryant Mill Pond** – Includes lower elevation floodplain/wetland areas adjacent to Portage Creek. The current creek channel is narrower as a result of the lowering of the Alcott Street Dam gates in 1976. Prior to the removal of these gates, the water level in Portage Creek was higher and ponding occurred over areas that are currently in the floodplain and wetland. Areas of sediment that were exposed after removal of Alcott Street Dam gates have since revegetated (CDM, 2008). The U.S. EPA conducted a removal action in the area in 1998 and 1999 to address PCBs in the sediment. The initial excavation was performed with an action level of 10 mg/kg and a goal of achieving post-excavation PCB concentrations less than or equal to 1 mg/kg.

- **Residential/Commercial Areas** – Is comprised of privately owned residential and commercial lands located outside of the eastern and western boundaries of OU1 where PCB concentrations and residuals were identified during the RI. Step-out sampling was performed to define the extent of impacts away from areas where residuals were observed. As a result, areas of higher concentration may be present and additional characterization may be required for comparison to the selected PRGs.

  This area includes, but is not limited to, the Panelyte Property (excluding the Panelyte Marsh), Stryker Corporation, Conrail, Clay Seam Area, East Bank Area, other properties and the Portage Creek adjacent to this area (CDM, 2008). This area includes surface and subsurface soil and sediment with varied land use. These properties listed above are not a part of OU1 as it has been defined. Any remediation in this area, proposed as a part of the OU1 FS, would be to clean up contamination that spread from OU1.

- **Former Operations Area** – The Former Operations Area includes Bryant historical residuals dewatering lagoon (HRDL) and former residuals dewatering lagoons (FRDLs), Monarch HRDL, Type III Landfill, Western Disposal Area, and the Alcott Street Properties. The landfill cap over the Bryant HRDL and FRDLs is at a higher elevation with lower elevation soils and wetlands present in the area (CDM, 2008). Interim response measures have been completed in the Former Operations Area since the early to mid 1990s and include the following actions:

  - Installation of 2,600 linear feet of sheet pile along the west bank of Portage Creek.
  - Removal and backfill of several hundred cubic yards (cy) of soil containing residuals from locations between the sheet pile wall and Portage Creek, and consolidation into the Bryant HRDL and FRDLs.
  - Removal and backfill of approximately 1,700 cy of residuals located within the floodplain on the east side of Portage Creek (East Bank area) in 2002, and consolidation into the Bryant FRDLs.
  - Construction of a landfill cap over the Bryant HRDL and FRDLs after consolidation of the soils and residuals as described above.
  - Design and installation of a groundwater recovery system to mitigate mounding of shallow groundwater behind the sheet pile along Portage Creek.

  The interim actions will be discussed and incorporated into the alternatives evaluated in the FS. As stated in the final Bryant Mill Pond Administrative Agreement, "The Bryant Mill Pond Area Removal Action is intended to be consistent with what U.S. EPA anticipates will be the final remedy to be selected by MDEQ" (U.S. EPA, 1998).

- **Panelyte Marsh** – The Panelyte Marsh is located at the southeastern end of the Panelyte property, north of the Western Disposal Area. Surface water from the Panelyte fill area and Western disposal area drains towards the Panelyte Marsh, which then drains to Portage Creek (CDM, 2008).

The boundaries presented in Figure 3 are consistent with the RI Report. These boundaries may need to be redefined during the feasibility study or remedial design. The remedial design will need to consider media definition and the current and planned future land-use for each area.

Identification and Development of PRGs

PCBs are the primary contaminant of concern and the risk driver at OU1 (CDM, 2008). Therefore, for the potentially complete pathways identified in the CSMs, a range of PRGs for PCBs were identified for the various media present. The PRGs were identified utilizing information from the HHRA, BERA, and chemical-specific applicable or relevant and appropriate requirements (ARARs).

Attachment 1 includes all the criteria that were considered and a discussion on the applicability and retention of the criteria as a potential PRG. Site-specific risk-based numbers presented in the HHRA and BERA and Part 201 Generic Cleanup Criteria were retained as PRGs for soil, sediment, and groundwater and are presented in Table 1. Screening levels presented in guidance documents (i.e. DOE Oak Ridge National Laboratory Screening levels) were identified, as shown in Attachment 1, but were not retained for further evaluation as PRGs.

PRGs are not included in this evaluation for surface water and fish tissue. By addressing soil, sediment, and groundwater sources, it is anticipated that the surface water and fish will be addressed over time. The fish consumption advisories will be maintained independent of this evaluation.

The relevance of PRGs for a specific area will depend upon the media present along with the receptors and current and future land use. The PRGs included in Table 1 for consideration are discussed below:

- Sediment criteria of 0.33 mg/kg, protective of human health based on consumption of fish. The risk-based criteria developed in the HHRA for protection of human health based on fish consumption are below the MDEQ ERD/SWQD detection limit of 0.33 mg/kg for sediment, so 0.33 mg/kg is the default sediment criteria (CDM, 2003a). The sediment criteria are also applied to areas that are inundated. The period of inundation that is applicable is currently being developed. The criteria was developed assuming the pathway from sediment to fish to consumer is complete.
- Under Michigan Rule 201 R299.5728 (f), the response action must provide for the effective control of contaminated soils from erosion.
- Sediment criteria of 0.5 mg/kg to 0.6 mg/kg protective of aquatic ecological receptors based on the NOAEL and LOAEL for mink (CDM, 2003b).
- Soil criteria of 2.5 mg/kg, protective of human health in a residential land-use scenario with exposure to contaminated soil via ingestion, dermal contact, and inhalation (CDM, 2003a).
- Soil criteria of 6.5 mg/kg to 8.1 mg/kg protective of terrestrial ecological receptors based on the NOAEL and LOAEL for the robin (CDM, 2003b).
- Soil criteria of 16 mg/kg, protective of human health in a commercial/industrial land-use scenario based on Part 201 criteria (MDEQ, 2004).
- Soil criteria of 23 mg/kg protective of human health for a recreationalist in a non-residential land-use scenario with exposure to contaminated soil via ingestion, dermal contact, and inhalation (CDM, 2003a).
- Groundwater criteria of 0.2 µg/L protective of surface water where a groundwater/surface water interface (GSI) is present based on Part 201 criteria (MDEQ, 2004).
- Groundwater criteria of 3.3 µg/L protective of human health through direct contact with groundwater based on Part 201 criteria (MDEQ, 2004).
- Removal of residuals observed in soil and sediment based on visual identification unless sufficient analytical data is available to demonstrate PCBs are not present above the applicable goals in a target area.

Sensitivities

This TM was prepared based on available information from the RI Report and assumptions in development of the CSM. The key assumptions and other limitations are summarized below:

- Area boundaries shown in Figure 3 are based on the RI study areas. Boundaries may require further evaluation and breakdown during the FS for application of the PRGs.
- The HHRA sediment cleanup criteria protective of human health from fish consumption has a range of 0.04 mg/kg to 0.30 mg/kg for PCBs. Because the MDEQ detection limit of 0.33 mg/kg for PCBs is greater than the risk-based level, the PRG protective of people consuming fish defaults to 0.33 mg/kg.
- Sediment criteria of 0.33 mg/kg is based on sediment to fish to human being complete pathway.
- PCB concentrations have been detected in the shallow groundwater aquifer. The drinking water pathway is considered incomplete at the site since no drinking water wells are present.
- The drinking water pathway may be incomplete for off site areas given the following reasons:
  - Several confining layers between the shallow and deep aquifers have been observed in city supply wells (CDM, 2008), that are located approximately 1 mile from the site.
  - An upward gradient from the deep to the shallow aquifer has been observed in the same nearby city supply wells (CDM, 2008).
  - No PCB contamination has been detected in the municipal well field sampling. The well field has been monitored for the last 20 years; however, with the exception of 2007, reporting limits were greater than the maximum contaminate level (MCL). Data from 2007 had reporting limits less than the MCL and PCBs were not detected in the samples.
  - PCBs are considered relatively insoluble and are thought to not migrate significantly in groundwater (CDM, 2008).
  - Onsite shallow groundwater flow is believed to follow the regional topography to the east where it discharges to Portage Creek (CDM, 2008).
  - Regionally, shallow groundwater flow is to the north, side gradient to the municipal well field located to the northwest of the site.

  Controls should be established within OU1 to prevent the installation of drinking water wells onsite and completion of the drinking water pathway. Zoning currently prevents installation of wells if public water supply is available. Should new information provide evidence of a completed drinking water pathway, the PRGs for groundwater will be re-evaluated.

– PRGs are not included in this evaluation for surface water and fish tissue. By addressing soil, sediment, and groundwater, it is anticipated that the surface water and fish will be addressed over time.

The default sediment criteria of 0.33 mg/kg for PCBs is roughly equivalent to the risk-based concentration of 0.30 mg/kg for the Sport Angler - Central Tendency based on fish consumption for 24 meals per year. OU1 is only one of five operable units in the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. This criteria was identified to be protective of human health whether an angler is catching fish only within this operable unit or within the site as a whole.

Future Use

It is U.S. EPA's intent that this summary of PRGs will be used by the Responsible Parties in the development of the FS. The information in this document will be compared to site-specific data and used in the development of an array of alternatives in the FS. U.S. EPA will use the information summarized in this TM in consideration of remedies for this OU.

References

CDM, 2003a. *Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site.* April 2003.

CDM, 2003b. *Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site.* April 2003.

CDM, 2008. *Allied Paper Inc. Operable Unit Remedial Investigation Report, for the Allied Paper, Inc/Portage Creek/Kalamazoo River Superfund Site.* April 2008.

MDEQ, 2004. *RRD Operational Memorandum No. 1, Part 201 Cleanup Criteria, Part 213 Risk-based Screening Levels.* December 10, 2004.

MDEQ, 2008 *Interdepartmental Communication Brant Fisher, Environmental Engineer Specialist to Paul Bucholtz/Project Manager, Remedial Investigation Report - Allied Disposal Site.* April 30, 2008.

U.S. EPA, 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A).* Office of Emergency and Remedial Response. U.S. EPA/540/1-89/002

U.S. EPA. 1998. CERCLA Docket No. V-W-98-C-473. Final Administrative Agreement executed by the US Department of Justice on June 2, 1998.

Figures

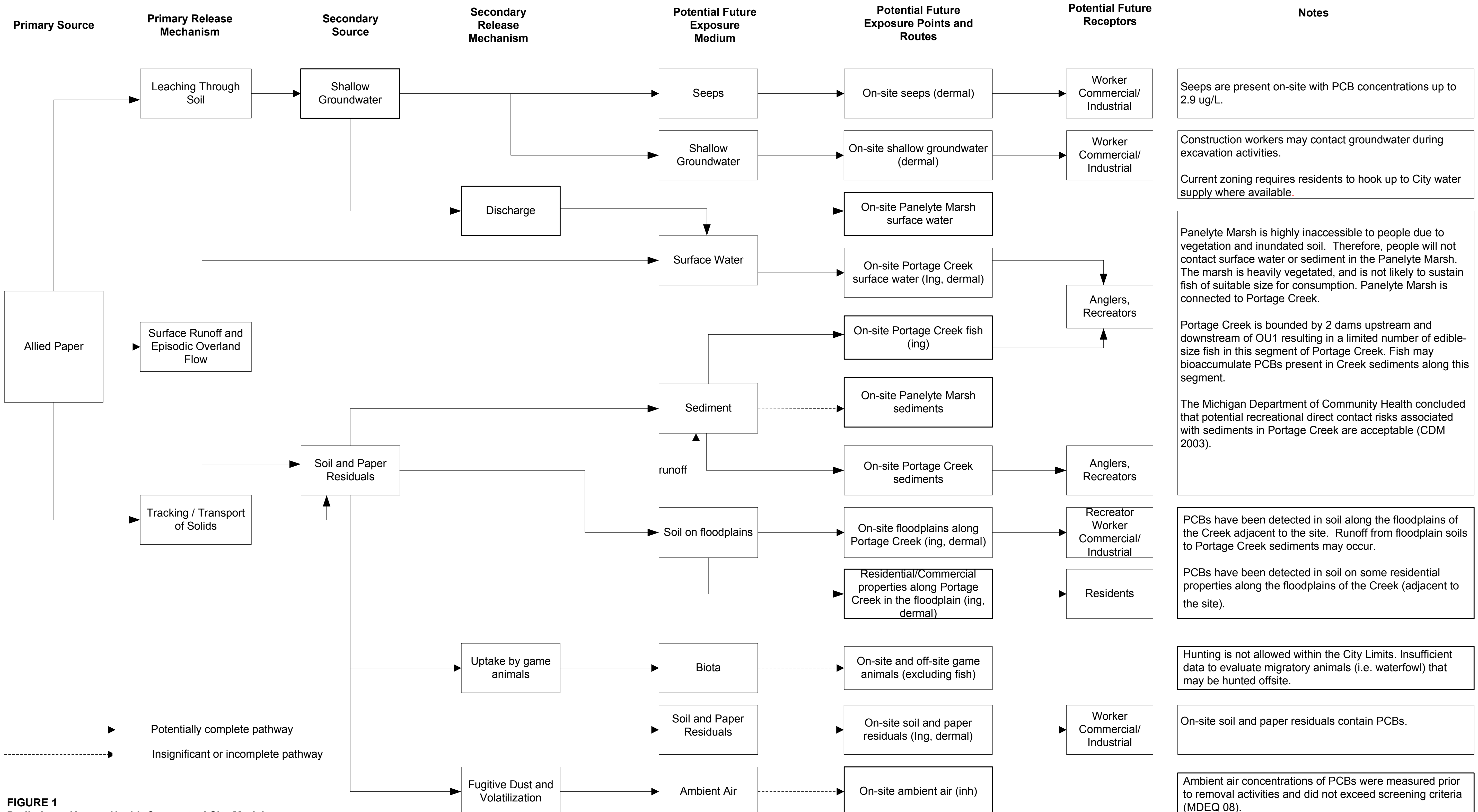


FIGURE 1
Preliminary Human Health Conceptual Site Model
Allied Paper OU-1

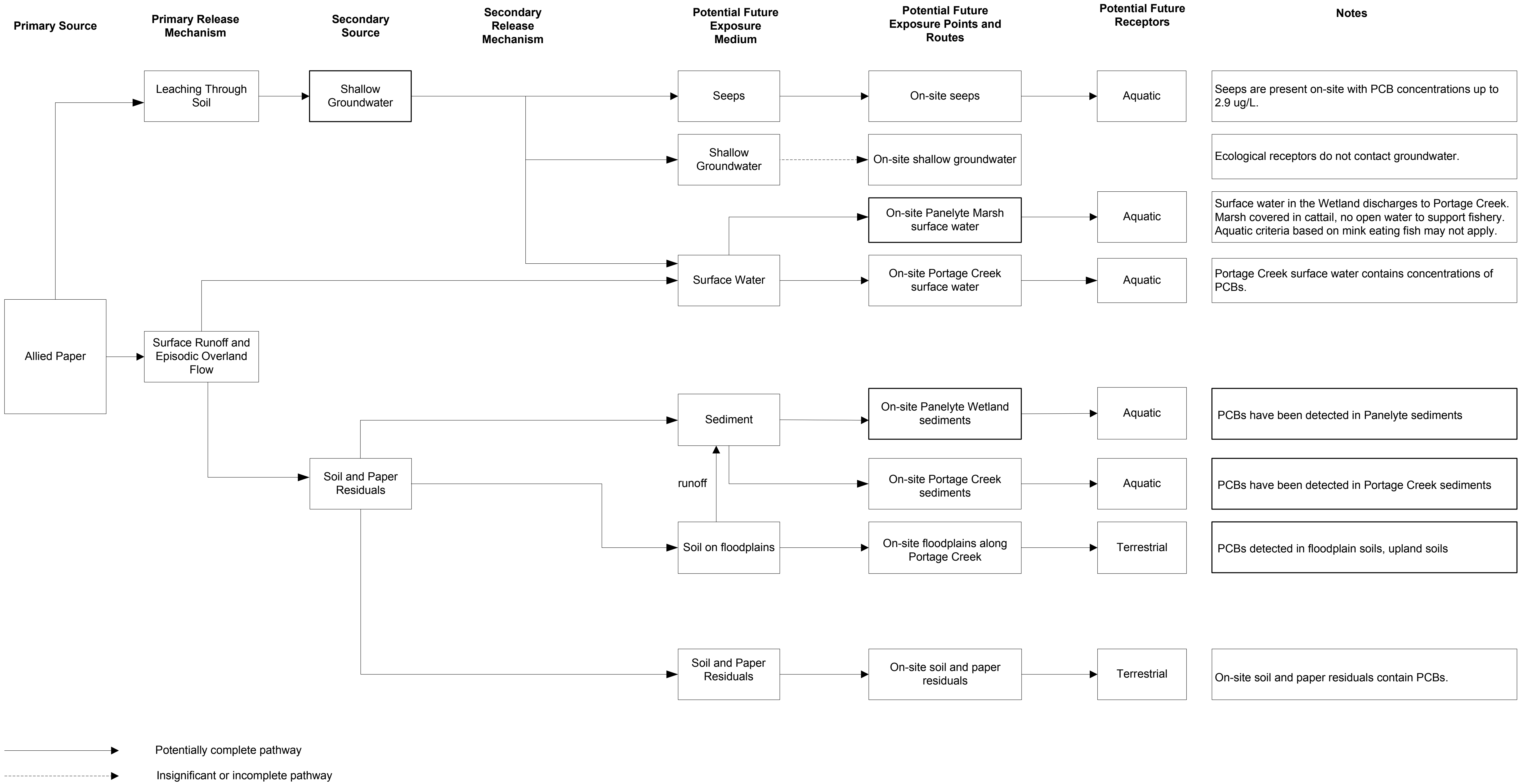


FIGURE 2
Preliminary Ecological Conceptual Site Model
Allied Paper OU-1

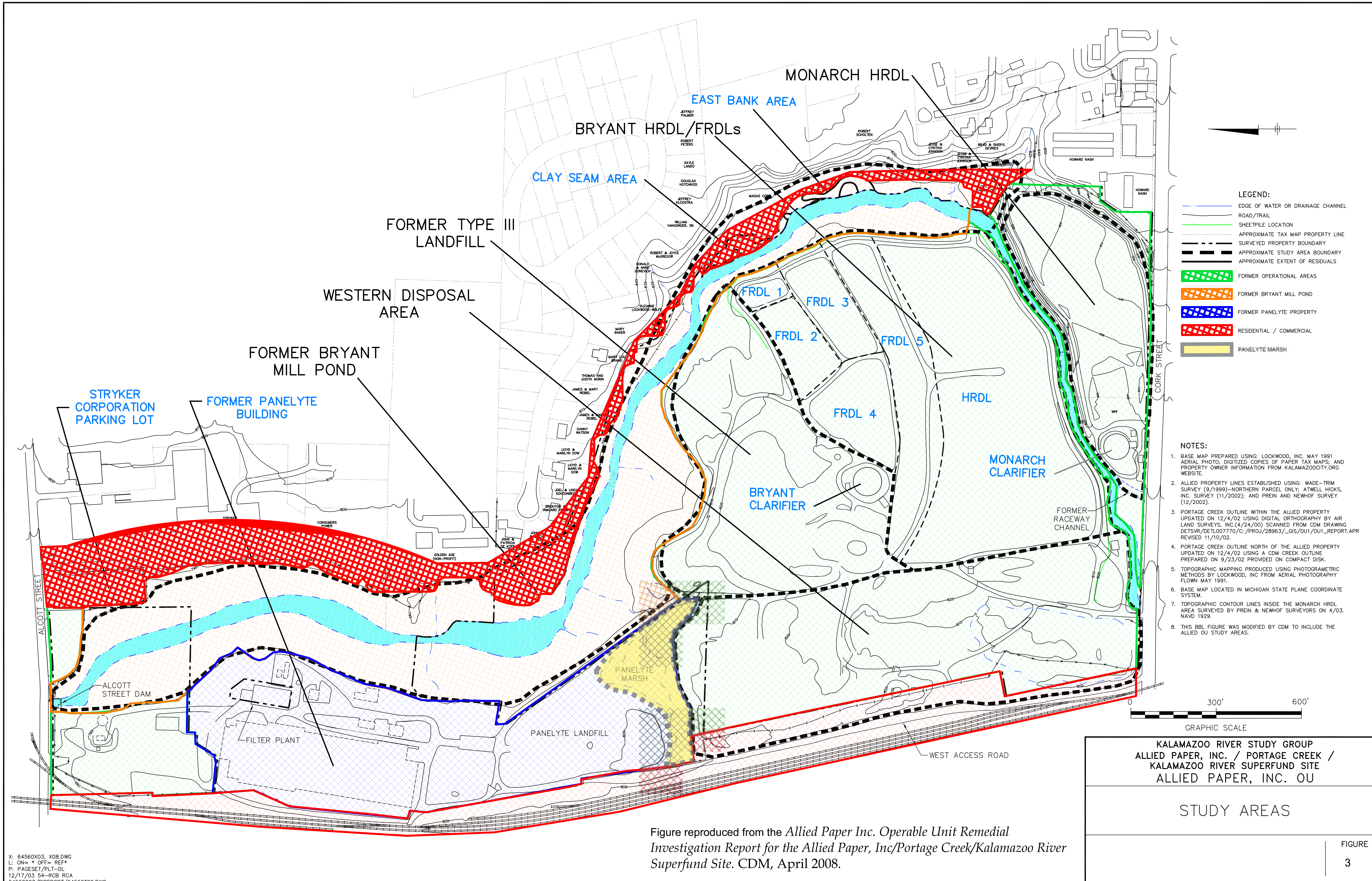


Figure reproduced from the *Allied Paper Inc. Operable Unit Remedial Investigation Report for the Allied Paper, Inc/Portage Creek/Kalamazoo River Superfund Site.* CDM, April 2008.

Tables

Table 1
Preliminary Remedial Goals
Draft Preliminary Remedial Goal Identification

Media	Pathway		Source	Preliminary Remedial Goals
Surface Soils	Human Health	Fish Consumption [1]	HHRA	0.33 mg/kg [1]
		Residential	HHRA	2.5 mg/kg
		Commercial II /Industrial	201 Generic Cleanup Criteria	16 mg/kg
		Recreationalist	HHRA	23 mg/kg
	Ecological	Aquatic	BERA	0.5 mg/kg / 0.6 mg/kg
		Terrestrial	BERA	6.5 mg/kg / 8.1 mg/kg
Subsurface Soils	Human Health	Residential	HHRA	2.5 mg/kg
		Commercial II /Industrial	201 Generic Cleanup Criteria	16 mg/kg
		Commercial/Industrial	HHRA	23 mg/kg
	Ecological	Terrestrial	BERA	6.5 mg/kg / 8.1 mg/kg
Surface Sediments	Human Health	Fish Consumption	HHRA	0.33 mg/kg
	Ecological	Aquatic	BERA	0.5 mg/kg / 0.6 mg/kg
Subsurface Sediment	Human Health	Fish Consumption	HHRA	0.33 mg/kg
	Ecological	Aquatic	BERA	0.5 mg/kg / 0.6 mg/kg
Groundwater (including seeps)	Human Health [2]		201 Generic Cleanup Criteria	3.3 µg/L
	Surface Water [3]		201 Generic Cleanup Criteria	0.2 µg/L

[1] Default sediment criteria of 0.33 mg/kg will be applied to shallow soil in areas of periodic inundation due to the potential runoff of shallow soils into surface water. Evaluation of contaminated soil runoff to surface water required under R299.5728(f)

[2] Groundwater for use as drinking water is not considered a complete pathway so the Part 201 Drinking Water criteria of 0.5 µg/L was not used. The Part 201 direct contact criteria was used for protection of human health due to the presence of seeps.

[3] The groundwater criteria protective of surface water is a PRG where the GSI is present.

Attachment 1

Summary of Suggested Remedial Goals and Applicable or Relevant and Appropriate Requirements

Citation	Summary of Requirement	Criteria
Soil		
Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. CDM, April 2003	The HHRA calculated risk-based concentrations (RBCs) for PCBs in soil protective of residents and recreationalists. RBCs were developed for both cancer and noncancer endpoints. Risk-based concentrations were developed for PCBs using an allowable cancer risk of 1 in 100,000 and a noncancer hazard index of 1.0. The RBC for soil would be protective of residents exposed to contaminated soil via ingestion, dermal contact, and inhalation. For the cancer endpoint the RBC for soil is 2.5 mg/kg. For noncancer endpoints, the RBC is 15 mg/kg for the reproductive endpoint and 4 mg/kg for the immunological endpoint. RBCs protective of recreationalists exposed to contaminated soil via ingestion, dermal contact, and inhalation include a RBC 23 mg/kg for cancer endpoints. For noncancer endpoints, the RBC is 139 mg/kg for the reproductive endpoint and 32 mg/kg for the immunological endpoint. The HHRA criteria are site-specific values calculated for the Kalamazoo River Superfund Site. The 1E-05 values calculated for cancer endpoints are the most protective values and were retained as PRGs for residential (2.5 mg/kg) land use and for protection of a recreationalist with non-residential land use (23 mg/kg).	<u>Residential</u> 1E-5 RIsk 2.5 mg/kg HI = 1.0 (immunological) 4 mg/kg HI = 1.0 (reproductive) 15 mg/kg <u>Non-residential</u> 1E-5 RIsk 23 mg/kg HI = 1.0 (immunological) 32 mg/kg HI = 1.0 (reproductive) 139 mg/kg
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451 (Part 7 R299.5701- 5707, 5718-5752)	Provides generic cleanup criteria and screening levels for direct contact with soil. Part 7 adopts the criteria established by TSCA; however, it also provides direct contact criteria for soil if TSCA standards are not applicable. If TSCA standards are not applicable, Generic Residential Land Use Criteria of 4 mg/kg PCB (soil) is established to be protective of human health for residential land-use under Part 201, Environmental Remediation of Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. If TSCA standards are not applicable, Generic Commercial II and Industrial Land Criteria of 16 mg/kg PCBs (soil) is established to be protective of human heath for onsite workers and/or trespassers under Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. The Part 201 Residential cleanup criteria of 4 mg/kg is less protective than the residential criteria developed in the HHRA and was therefore not retained as a PRG.	Residential 4 mg/kg Industrial 16 mg/kg

Citation	Summary of Requirement	Criteria	
	The Part 201 Commercial / Industrial cleanup criteria of 16 mg/kg, was considered as a PRG for industrial / commercial land use.		
Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. CDM, April 2003.	The No Observed Adverse Effect Level (NOAEL) to Lowest Observed Adverse Effect Level (LOAEL) range from 6.5 mg/kg to 8.1 mg/kg PCB in soil for the protection of terrestrial ecological receptors (the American Robin) as established in the Baseline Ecological Risk Assessment (BERA). The BERA is currently under peer review, but was used for evaluation of PRGs. The NOAEL and LOAEL are site-specific values calculated for the Kalamazoo River Superfund Site and are retained as PRGs for evaluation of terrestrial ecological receptors.	NOAEL LOAEL	6.5 mg/kg 8.1 mg/kg
DOE Oak Ridge National Laboratory (ORNL) *Screening Levels for Chemical Contaminants* including the Region 9 PRG (http://epa-prgs.ornl.gov/chemicals/index.shtml)	Generic screening levels (SLs) are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in EPA's Risk Assessment Guidance for Superfund, Part B Manual (1991) and Soil Screening Guidance documents. The screening levels provided correspond to a 10-6 cancer risk for high risk PCBs, such as Aroclors 1242, 1248, 1254, and 1260. Region 9 Preliminary Remediation Goals (PRGs) protective of human health for the ingestion, inhalation and dermal contact exposure pathways for soil are 0.22 mg/kg for residential use (high risk PCBs) and 0.74 mg/kg for industrial land-use (high risk PCBs). Region 9 PRGs are intended for use as screening levels to determine if remedial actions may be necessary, but are not intended to be used as cleanup criteria. The Region 9 PRGs are not regulatory criteria or site-specific values and were not carried forward for further evaluation as PRGs.	Residential Industrial	0.22 mg/kg 0.74 mg/kg
USEPA, Office of Emergency and Remedial Response, EPA 540/G-90/007 (OSWER Directive 9355.4-01)	Describes the recommended approach for evaluating and remediating Superfund Sites with PCBs. Provides preliminary remediation goals for certain media and other considerations. Recommends that the goals for soils generally should be 1 ppm for residential areas, or higher (10–25 ppm) for sites where non-residential use is anticipated. The guidance document provides preliminary remedial goals based on land uses. These are not regulatory criteria or site-specific values, so the criteria were not retained as PRGs.	Residential Non-residential	1 mg/kg 10 - 25 mg/kg

Citation	Summary of Requirement	Criteria
Toxic Substance Control Act—Subpart D (40 CFR 761.50-761.79)	PCBs are regulated by Toxic Substance Control Act (TSCA) under 40 CFR 761. Subpart D of Part 761, Storage and Disposal, establishes procedures for self-implementing clean up of general, moderately-sized sites, including clean up criteria. In place of the self-implementing criteria, TSCA allows for site-specific risk-based criteria to be determined and used under 40 CFR 761.61 (c) *Risk-based disposal approval*. Site-specific values are provided in the HHRA so the TSCA Subpart D criteria were not retained as PRGs.	Residential & Commercial I 1 mg/kg 10 mg/kg if capped Industrial & Commercial II, III or IV 1 mg/kg 10 mg/kg if capped
Toxic Substance Control Act—Subpart G (53 U.S.C. 2301 et seq.; 40 CFR 761.120-761.135)	PCBs are regulated by the Toxic Substance Control Act (TSCA) under 40 CFR 761. Subpart G of Part 761, Spill Cleanup Policy, establishes the criteria by which spill cleanup should be judged. Subpart G applies only to spills that occurred after May 4, 1987. With few exceptions that are left to the discretion of USEPA (40 CFR 761.123 [d][2]), Subpart G promulgates soil cleanup levels for PCB spills of low and high concentrations. For low concentration spills involving less than 1 pound of PCBs by weight, TSCA Subpart G requires all soil within the spill area (i.e., the visible traces of a spill and the 1-foot lateral buffer zone surrounding the visible traces) to be excavated and the ground to be restored with backfill containing less than 1 ppm PCBs. For high concentration spills (or low concentration spills involving more than 1 pound of PCBs by weight), TSCA Subpart G promulgates soil cleanup levels of 10 mg/kg for nonrestricted access areas and 25 mg/kg for restricted access areas. Spills which occurred prior to May 4, 1987, are excluded from the scope of this policy and require site-by-site evaluation. Site-specific values are provided in the HHRA, so the TSCA Subpart G criteria were not retained as PRGs.	Nonrestricted access 10 mg/kg Restricted access 25 mg/kg
Sediment		
Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. CDM, April 2003	The HHRA sediment cleanup criteria protective of people consuming fish range from 0.04 mg/kg to 0.30 mg/kg PCB; however, because MDEQ has a detection limit of 0.33 mg/kg for PCBs, the cleanup criteria protective for people consuming fish defaults to 0.33 mg/kg. The risk based concentrations (RBCs) from the HHRA are presented below: RBC for 1E-05 based on Bass/Carp Ingestion Subsistence angler (179 meals/yr) 0.04 mg/kg Sport angler – high end (125 meals/yr) 0.12 mg/kg Sport angler – central tendency (24 meals/yr) 0.30 mg/kg	Default 0.33 mg/kg

Citation	Summary of Requirement	Criteria
	<u>RBC for HQ = 1 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.07 mg/kg Sport angler – high end (125 meals/yr) 0.20 mg/kg Sport angler – central tendency (24 meals/yr) 0.52 mg/kg The default criteria of 0.33 mg/kg was evaluated as a PRG since the HHRA criteria calculated for the angler are below the analytical detection limit. The default criteria of 0.33 mg/kg was retained as a PRG for sediment.	
Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. CDM, April 2003.	The No Observed Adverse Effect Level (NOAEL) to Lowest Observed Adverse Effect Level (LOAEL) range of 0.5 mg/kg to 0.6 mg/kg PCB in sediment for the protection of aquatic ecological receptors (mink) as established in the BERA. The BERA is currently under review, but was used for evaluation of PRGs. The NOAEL and LOAEL for aquatic receptors are site-specific values calculated for the Kalamazoo River Superfund Site. The NOAEL and LOAEL were retained for consideration as PRGs.	NOAEL 0.5 mg/kg LOAEL 0.6 mg/kg
Toxic Substance Control Act—Subpart D (40 CFR 761.50-761.79)	PCBs are regulated by Toxic Substance Control Act (TSCA) under 40 CFR 761. Subpart D of Part 761, Storage and Disposal, establishes procedures for self-implementing clean up criteria for general, moderately sized sites. The self-implementing criteria are not to be used for sediments. In place of the self-implementing criteria, TSCA allows site-specific risk-based criteria to be determined and used under 40 CFR 761.61 (c) *Risk-based disposal approval*. Site specific values are provided in the HHRA so the TSCA Subpart D criteria were not retained as PRGs.	<u>Residential & Commercial I</u> 1 mg/kg 10 mg/kg if capped <u>Industrial & Commercial II, III or IV</u> 1 mg/kg 10 mg/kg if capped
USEPA, Office of Emergency and Remedial Response, EPA 540/G-90/007 (OSWER Directive 9355.4-01)	*Guidance on Remedial Actions for Superfund Sites with PCB Contamination* prepared by the USEPA, Office of Emergency and Remedial Response, EPA 540/G-90/007 (OSWER Directive 9355.4-01), describes the recommended approach for evaluating and remediating Superfund Sites with PCBs and provides preliminary remediation goals for certain media and other considerations. Interim sediment quality criteria for PCBs are shown in Table 3-5 from the *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*. The guidance document provides a method to determine cleanup levels based on site conditions and assumptions, but does not provide a criteria. This is not a regulatory criteria or site-specific value and was therefore not retained as a PRG.	Based on percent organic carbon (%OC)

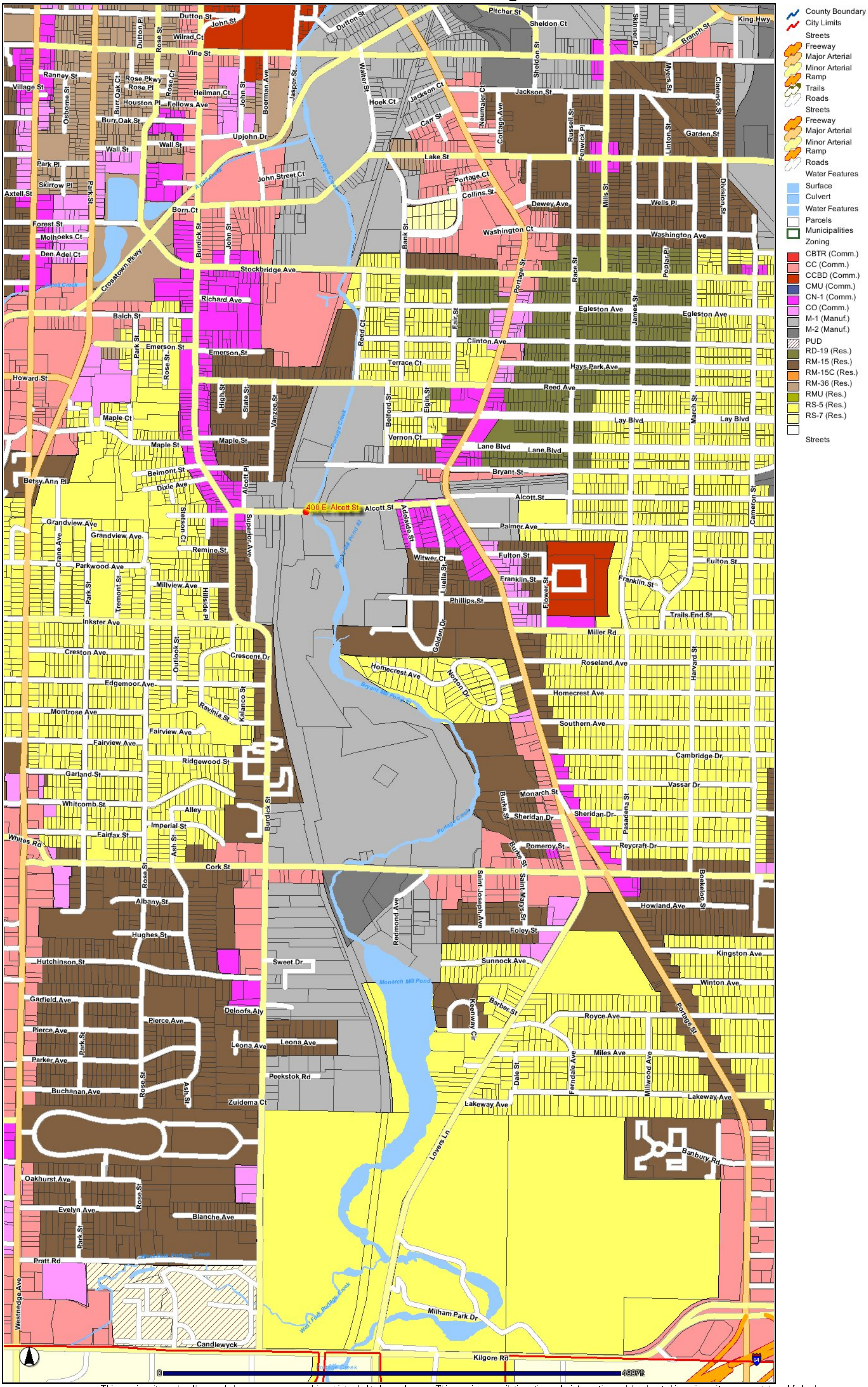
Citation	Summary of Requirement	Criteria	
Groundwater			
DOE Oak Ridge National Laboratory (ORNL) *Screening Levels for Chemical Contaminants* including the Region 9 PRG (http://epa-prgs.ornl.gov/ chemicals/index.shtml)	Generic screening levels are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in EPA's Risk Assessment Guidance for Superfund, Part B Manual (1991). The screening levels provided correspond to a 10^{-6} cancer risk for high risk PCBs, such as Aroclors 1242, 1248, 1254, and 1260. Region 9 Preliminary Remediation Goals (PRG) protective of human health for the ingestion and inhalation exposure pathways is 0.034 µg/L for tap water (high risk PCBs). Region 9 PRGs are intended for use as screening levels to determine if remedial actions may be necessary, but are not intended to be used as cleanup criteria. The screening levels are not regulatory criteria or site-specific values and were not carried forward for further evaluation as PRGs. In addition, a completed pathway is not currently believed to be present for ingestion of the shallow groundwater.	Tap Water	0.034 µg/L
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451 (Part 7 R299.5701- 5707, 5718-5752)	Groundwater Surface Water Interface (GSI) Criteria of 0.2 µg/L is presented in Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. The calculated criterion is below the analytical target detection limit; therefore, the criterion defaults to the target detection limit. The Part 201 generic cleanup criteria for groundwater was retained as a PRG where the GSI is present on the site.	GSI	0.2 µg/L
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451 (Part 7 R299.5701- 5707, 5718-5752)	Generic Residential and Industrial-Commercial Drinking Water Standard of 0.5 µg/L for PCBs, is presented in Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules. Part 201 adopted the criterion which is the State of Michigan drinking water standard established pursuant to section 5 of 1976 PA 399, MCL 325.1005. A completed pathway is not currently believed to be present for ingestion of the shallow groundwater. A PRG for groundwater based on ingestion was not evaluated.	Drinking Water	0.5 µg/L
Michigan Natural Resources and Environmental Protection Act— Part 201 of Act 451	Groundwater Contact Criteria of 3.3 µg/L for PCBs, presented in Part 201, Environmental Remediation of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, and Part 201 Administrative Rules.	Direct Contact	3.3 µg/L

Citation	Summary of Requirement	Criteria
(Part 7 R299.5701- 5707, 5718-5752)	A shallow water table is present in the area with the expression of seeps to the ground surface. The Part 201 generic cleanup criteria to be protective of human health through contact with groundwater was retained as a PRG.	
Surface Water		
Clean Water Act—Water Quality Standards (33 U.S.C. 1311 et. seq.; 40 CFR 131)	The Clean Water Act and the Michigan Natural Resources and Environmental Protection Act regulate concentrations of PCBs in surface waters. According to the Clean Water Act National Toxics Rule (40 CFR 131.36; as updated by USEPA on November 9, 1999 [64 *FR* 61181]), the water quality criterion for total PCBs in surface water is 0.00017 µg/L for both the water-and-organism consumption and water-only consumption human health criteria. The 2002 update to the National Recommended Water Quality Criteria established pursuant to Section 303(a) of the Clean Water Act for total PCBs are 0.000064 µg/L for both types of human health criteria and 0.014 µg/L for the freshwater aquatic life criteria continuous concentration. PRGs were not developed for surface water. PCBs in surface water will be addressed as a result of remedial actions for soil and sediment.	<u>1999</u> Human Health 0.00017 µg/L <u>2002 Update</u> Human Health 0.000064 µg/L Freshwater Aquatic Life 0.014 µg/L
Michigan Natural Resources and Environmental Protection Act –Part 31 of Act 451 (Part 4 R323.1041-1117)	According to Part 4 (Water Quality Standards) Rule 57 (Toxic Substances) of the Administrative Rules for Part 31 (Water Resources Protection) of the Michigan Administrative Code, the acceptable levels of PCBs in surface water are 0.000026 µg/L for human health (both drinking and nondrinking uses) and 0.00012 µg/L for wildlife. PRGs were not developed for surface water. PCBs in surface water will be addressed as a result of remedial actions for soil and sediment.	Human Health 0.000026 µg/L Wildlife 0.00012 µg/L
Final (Revised) Baseline Ecological Risk Assessment (BERA) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. CDM, April 2003.	The No Observed Adverse Effect Level (NOAEL) to Lowest Observed Adverse Effect Level (LOAEL) range from 0.00098 µg/L to 0.00197 µg/L PCB for the protection of aquatic ecological receptors (mink) as established in the BERA. The BERA is currently under review, but the NOAEL and LOAEL are provided for comparison to other potential ARARs. PRGs were not developed for surface water. PCBs in surface water will be addressed as a result of remedial actions for soil and sediment.	NOAEL 0.00098 µg/L LOAEL 0.00197 µg/L
Fish Tissue		
Food and Drug Administration	Tolerances for PCBs in food for human consumption are identified in 21 CFR 109.30 for residues of PCB as unavoidable environmental or industrial contaminants in foods	Fish fillets 2 mg/kg

Citation	Summary of Requirement	Criteria
Tolerances for PCBs in food for human consumption (21 CFR 109.30)	for human consumption “until the elimination of such contaminants at the earliest possible time.” Temporary tolerance for PCBs in the edible portions of fish (excludes head, scales, viscera, and inedible bones) is 2 ppm. Provides guidance for actions involving fish consumption advisories. PRGs were not developed for fish. PCBs in fish will be addressed through remedial actions for soil and sediment.	
Michigan Department of Community Health (MDCH) Fish Contaminant Monitoring Program (FCMP) (referenced from HHRA)	The MDCH Fish Contaminant Monitoring Program evaluates fish samples for PCBs and other potential contaminants in determination of fish consumption advisories. The Trigger Levels for total PCBs in fish as determined by the MDCH Fish Contaminant Monitoring Program are as shown. PRGs were not developed for fish. PCBs in fish will be addressed through remedial actions for soil and sediment. The fish consumption advisories will be maintained independent of this evaluation.	General Population 2.0 mg/kg Women of Child-Bearing Age and Children Under 15 1 meal/ wk 0.05 mg/kg 1 meal/mo 0.2 mg/kg 6 meals/yr 1.0 mg/kg No consumption 1.9 mg/kg
Final (Revised) Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. CDM, April 2003.	Risk-based fish concentrations were developed to be protective of sport and subsistence anglers for both cancer and noncancer endpoints. Risk-based concentrations were developed for PCBs using an allowable cancer risk of 1 in 100,000 and a noncancer hazard index of 1.0. For the noncancer risk, only the immunological endpoint was calculated because this is more protective than the reproductive endpoint and is always a lesser concentration. The RBCs represent the concentration in the fillet. <u>RBC for 1E-05 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.015 mg/kg Sport angler – high end (125 meals/yr) 0.042 mg/kg Sport angler – central tendency (24 meals/yr) 0.109 mg/kg <u>RBC for HQ = 1 based on Bass/Carp Ingestion</u> Subsistence angler (179 meals/yr) 0.025 mg/kg Sport angler – high end (125 meals/yr) 0.072 mg/kg Sport angler – central tendency (24 meals/yr) 0.187 mg/kg PRGs were not developed for fish. PCBs in fish will be addressed through remedial actions for soil and sediment.	RBC for 1E-05 risk based on Bass/Carp Ingestion range from 0.015 mg/kg to 0.109 mg/kg.

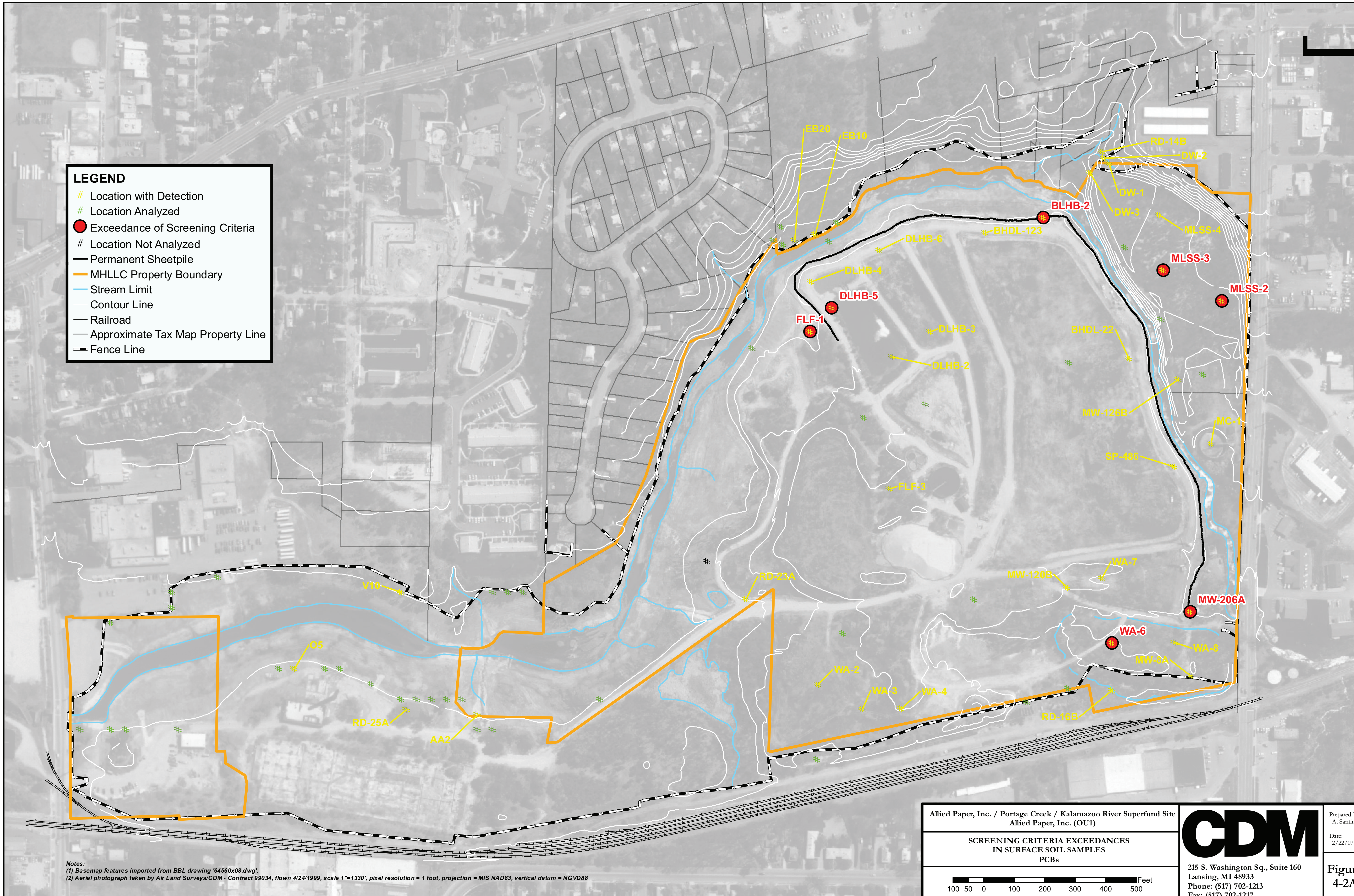
Appendix C
Allied Zoning Map

Allied Zoning



This map is neither a legally recorded map nor a survey and is not intended to be used as one. This map is a compilation of records, information and data located in various city, county, state and federal offices and other sources regarding the area shown, and is to be used for reference purposes only. Created From City of Kalamazoo Online Mapping Site. Sources: Kalamazoo, MI. Data Dates: 2009: County Basemap; 2008: Rentals Daily; Dec., Section Lines; Nov., Mowing Properties; Sept., Ownership Info; Jan., Parcels, Zoning, Landuse, Bus Stops, Bus Routes; 2007: October, Centerlines; June, Voting Precincts; Apr., School Prop.; 2006: Aug., Parking; Feb., Soils, Trees, NWI Wetlands; 2004: Dec., Elevation Contours; Nov., Structures and Roads; Aug., Bus Routes; June, Brownfields; all others Fall 2003. Map Created: 3/24/2011

Appendix D
Selected RI Tables and Figures



Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

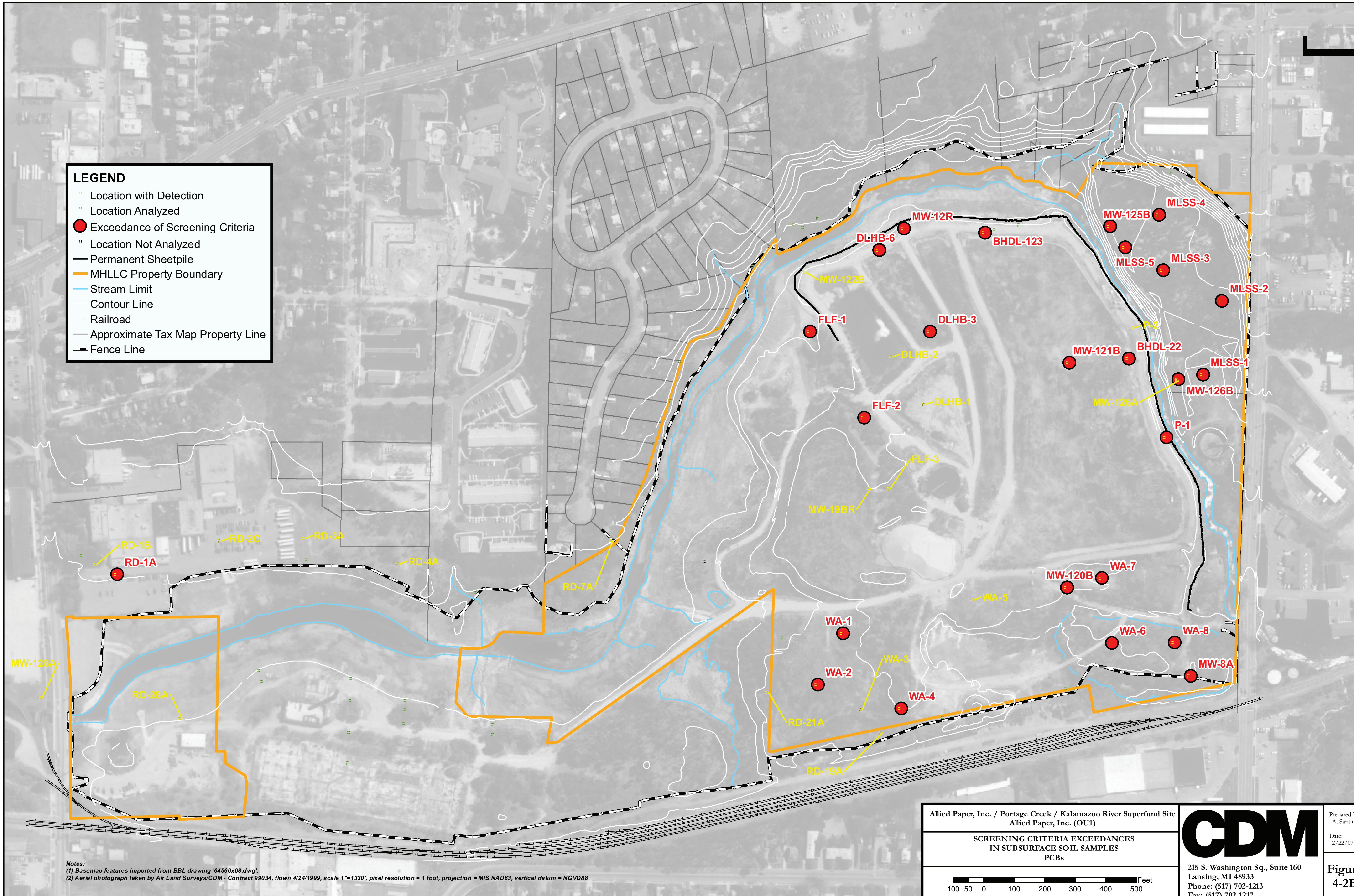
SCREENING CRITERIA EXCEEDANCES
IN SURFACE SOIL SAMPLES
PCBs

CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By: A. Santini

Date: 2/22/07

Figure 4-2A



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(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN SUBSURFACE SOIL SAMPLES
PCBs

CDM
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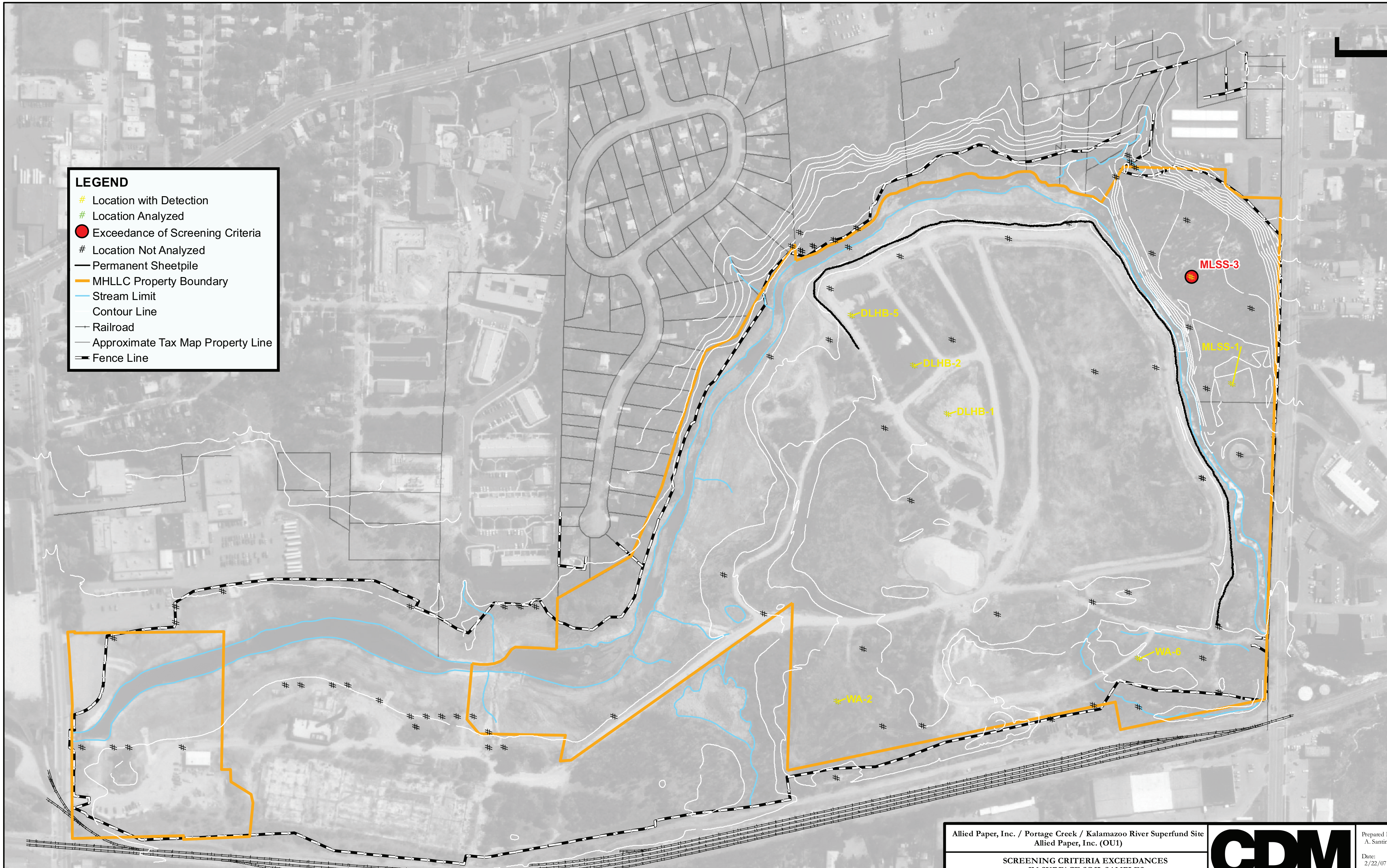
Prepared By:
A. Santini

Date:
2/22/07

Figure
4-2B



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(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN SURFACE SOIL SAMPLES
PCDD/PCDF

CDM

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Phone: (517) 702-1213
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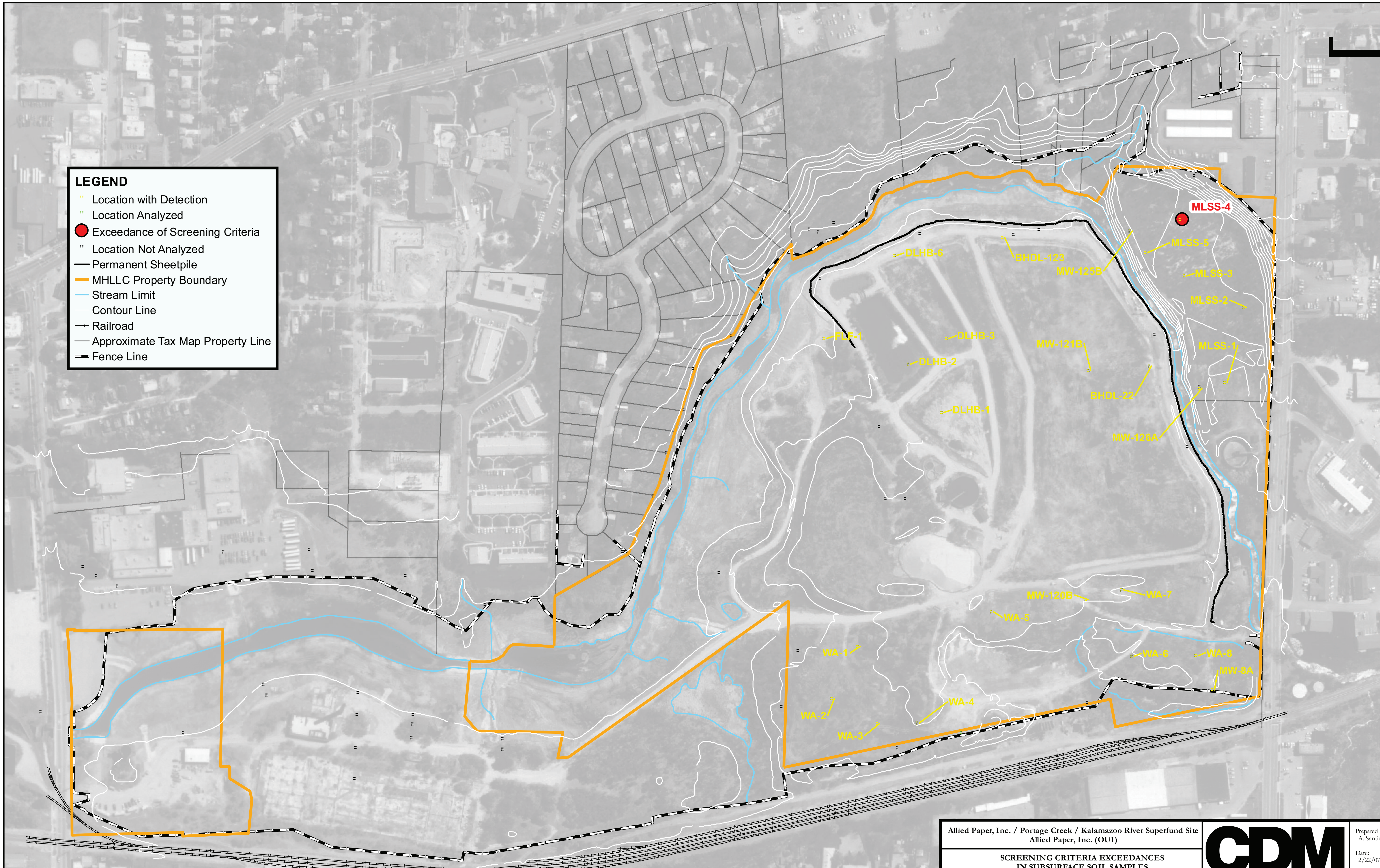
Prepared By:
A. Santini

Date:
2/22/07

Figure
4-2C



Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

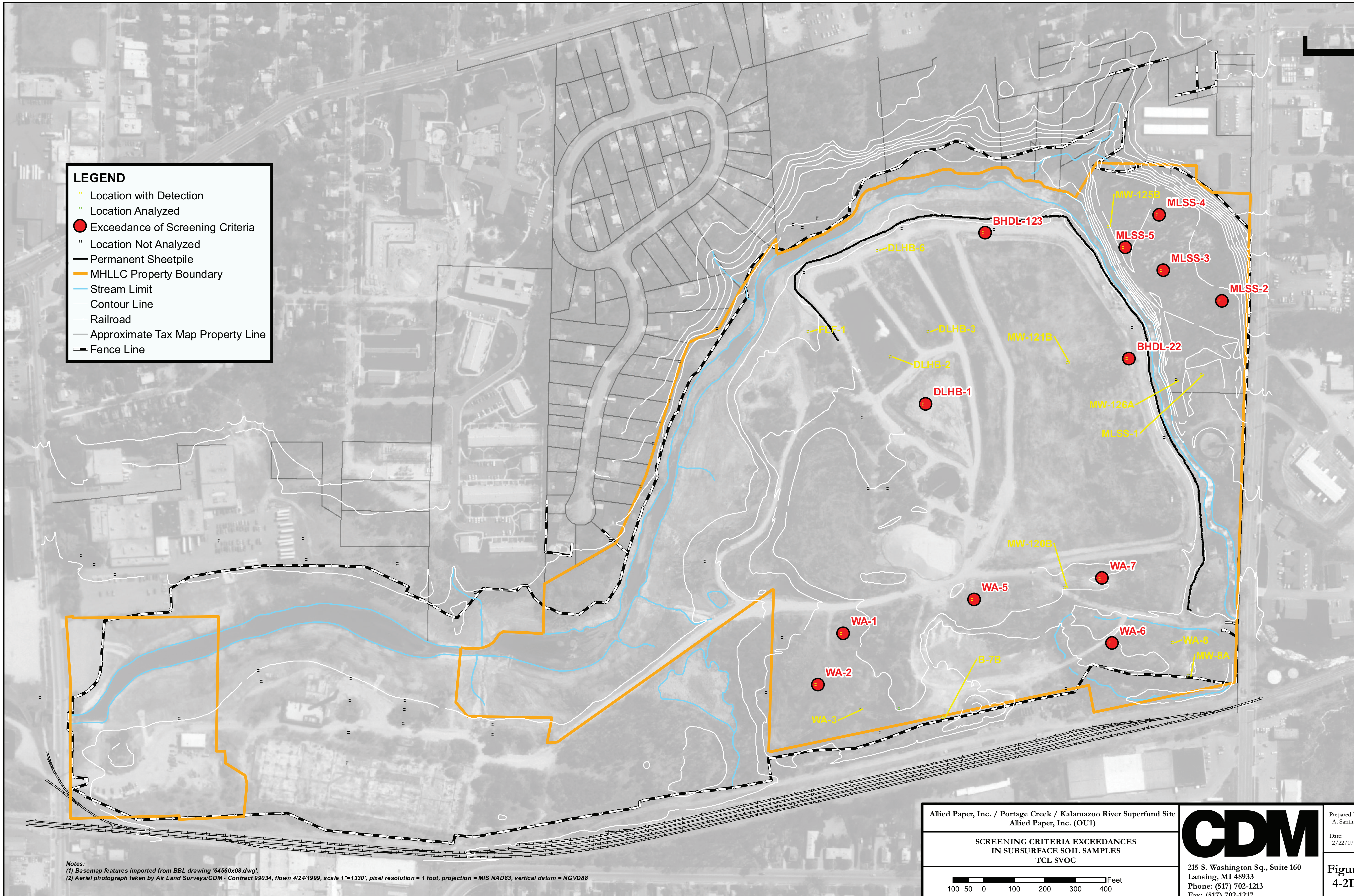
SCREENING CRITERIA EXCEEDANCES
IN SUBSURFACE SOIL SAMPLES
TCL VOC

CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

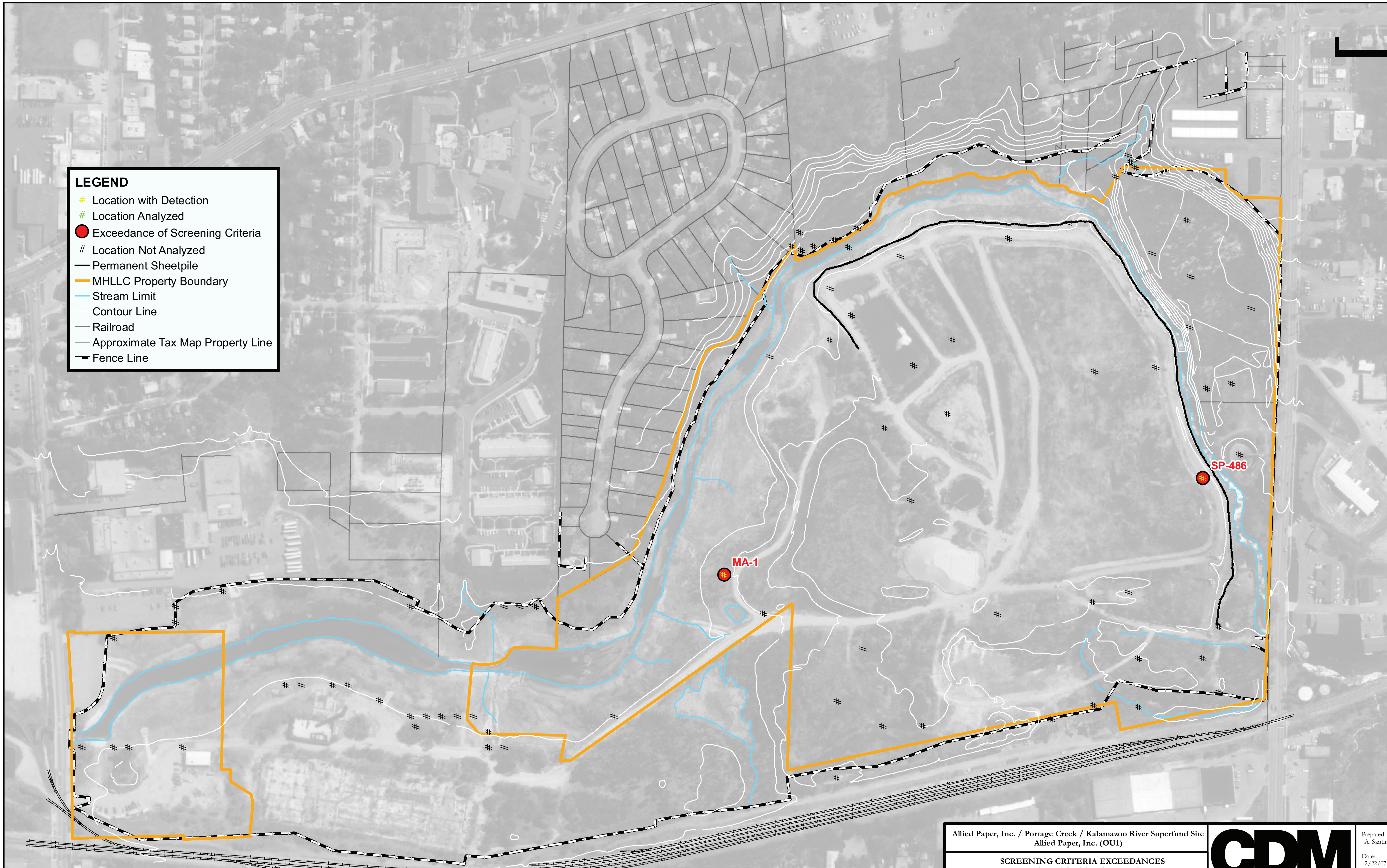
Prepared By:
A. Santini

Date:
2/22/07

Figure
4-2D



LEGEND
Location with Detection
Location Analyzed
Exceedance of Screening Criteria
Location Not Analyzed
Permanent Sheetpile
MHLLC Property Boundary
Stream Limit
Contour Line
Railroad
Approximate Tax Map Property Line
Fence Line
MW-125B
MLSS-4
BHDL-123
MLSS-5
MLSS-3
DLHB-6
MLSS-2
FLF-1
DLHB-3
MW-121B
BHDL-22
DLHB-2
DLHB-1
MW-126A
MLSS-1
MW-120B
WA-7
WA-5
WA-1
WA-6
WA-8
MW-8A
B-7B
WA-2
WA-3
Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88
Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)
SCREENING CRITERIA EXCEEDANCES
IN SUBSURFACE SOIL SAMPLES
TCL SVOC
Feet
100 50 0 100 200 300 400
CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217
Prepared By:
A. Santini
Date:
2/22/07
Figure
4-2E



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(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

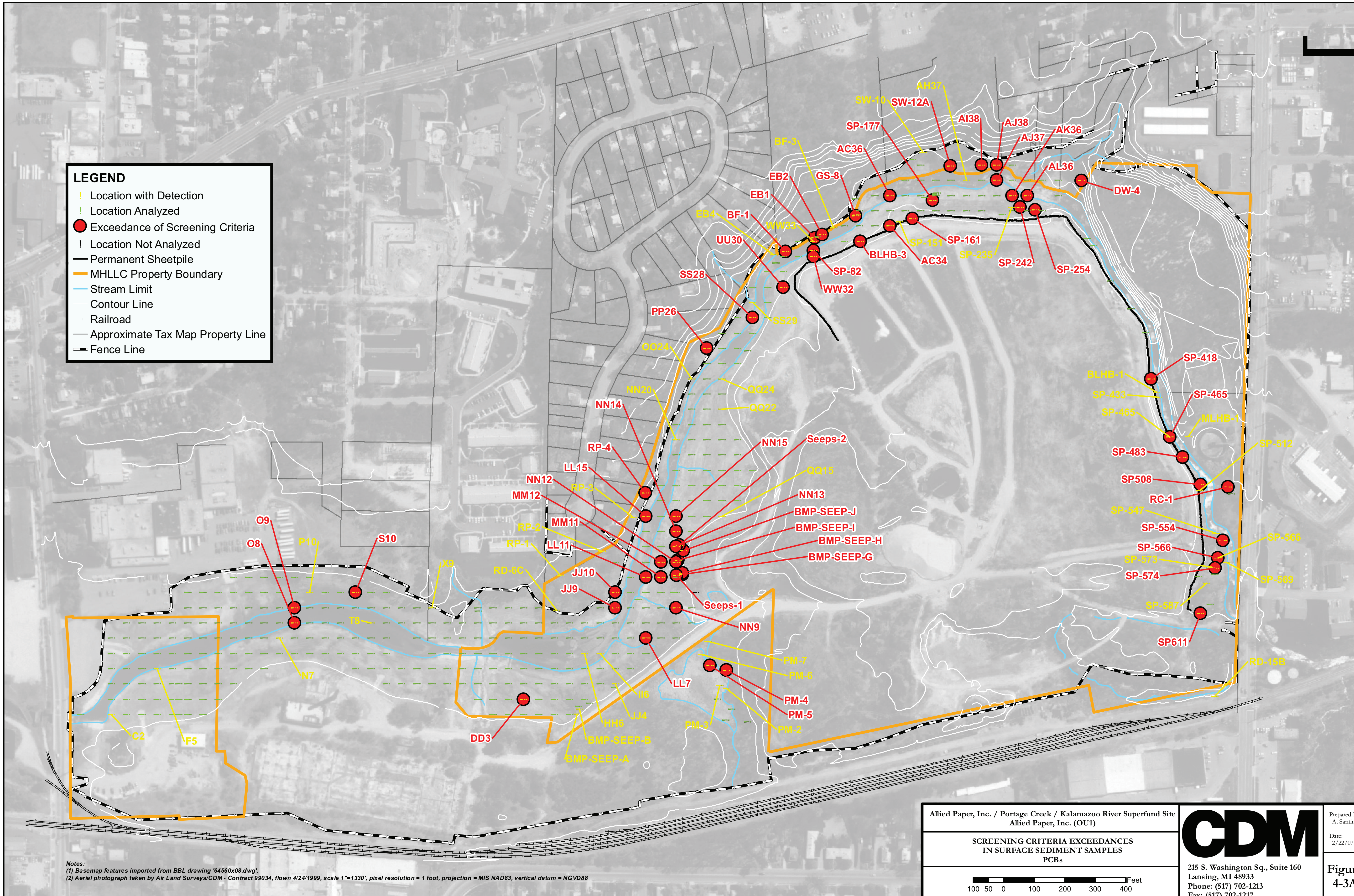
SCREENING CRITERIA EXCEEDANCES
IN SURFACE SOIL SAMPLES
TAL INORGANICS

CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By:
A. Santini

Date:
2/22/07

Figure
4-2F



Notes:
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(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN SURFACE SEDIMENT SAMPLES
PCBs

100 50 0 100 200 300 400 Feet

CDM

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Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By:
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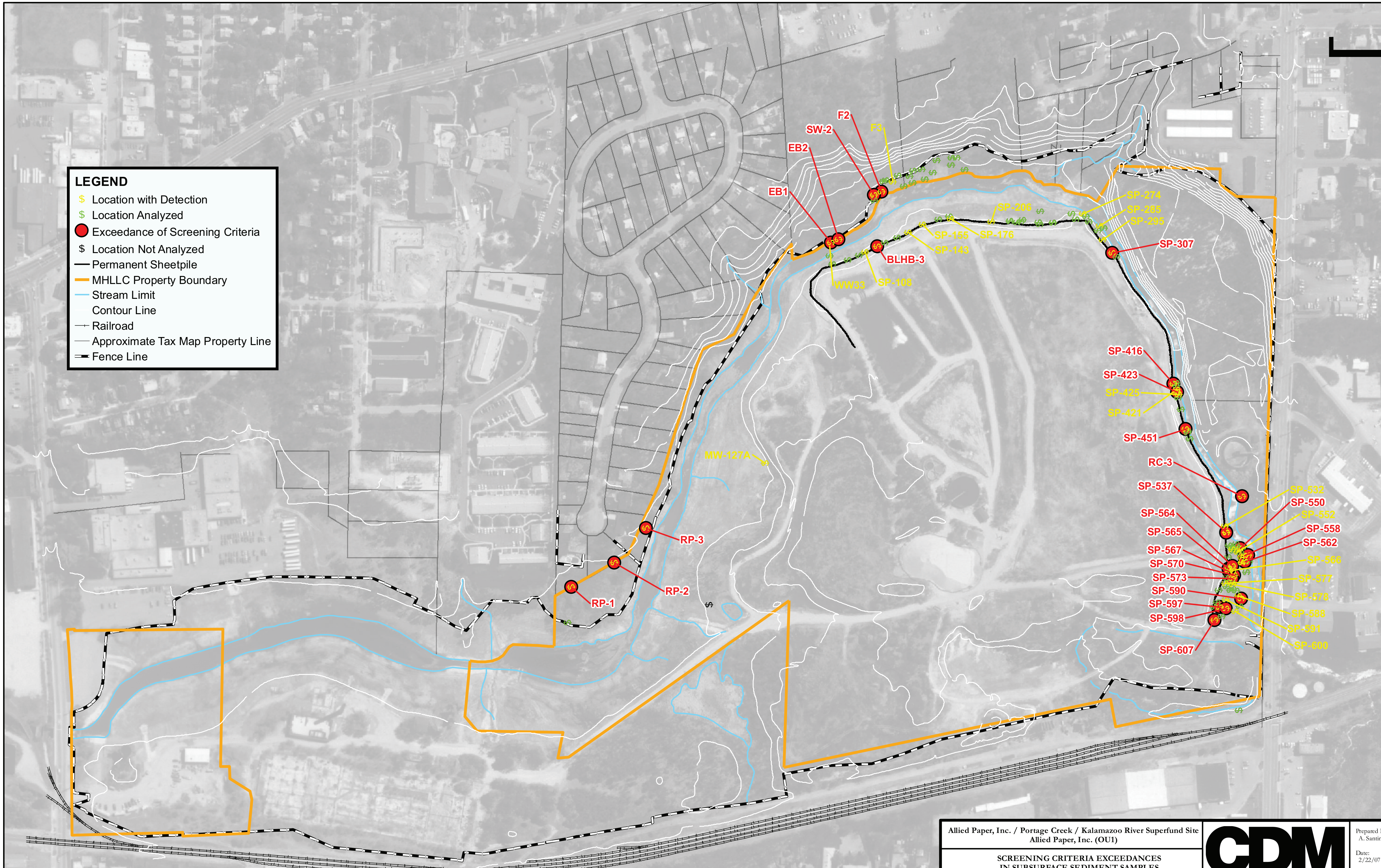
Date:
2/22/07

Figure
4-3A



Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN SUBSURFACE SEDIMENT SAMPLES
PCBs

CDM

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Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By:
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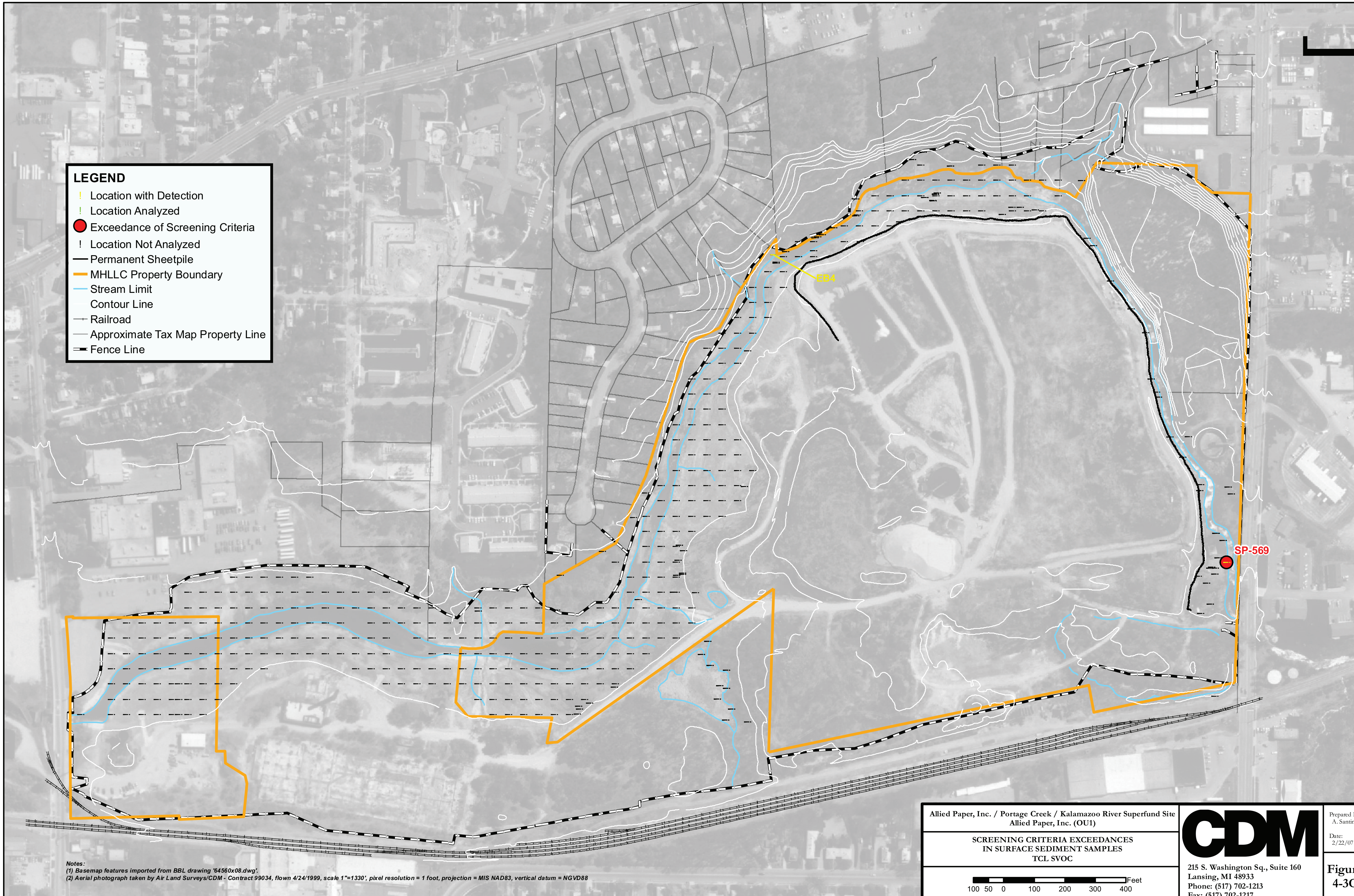
Date:
2/22/07

Figure 4-3B



Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

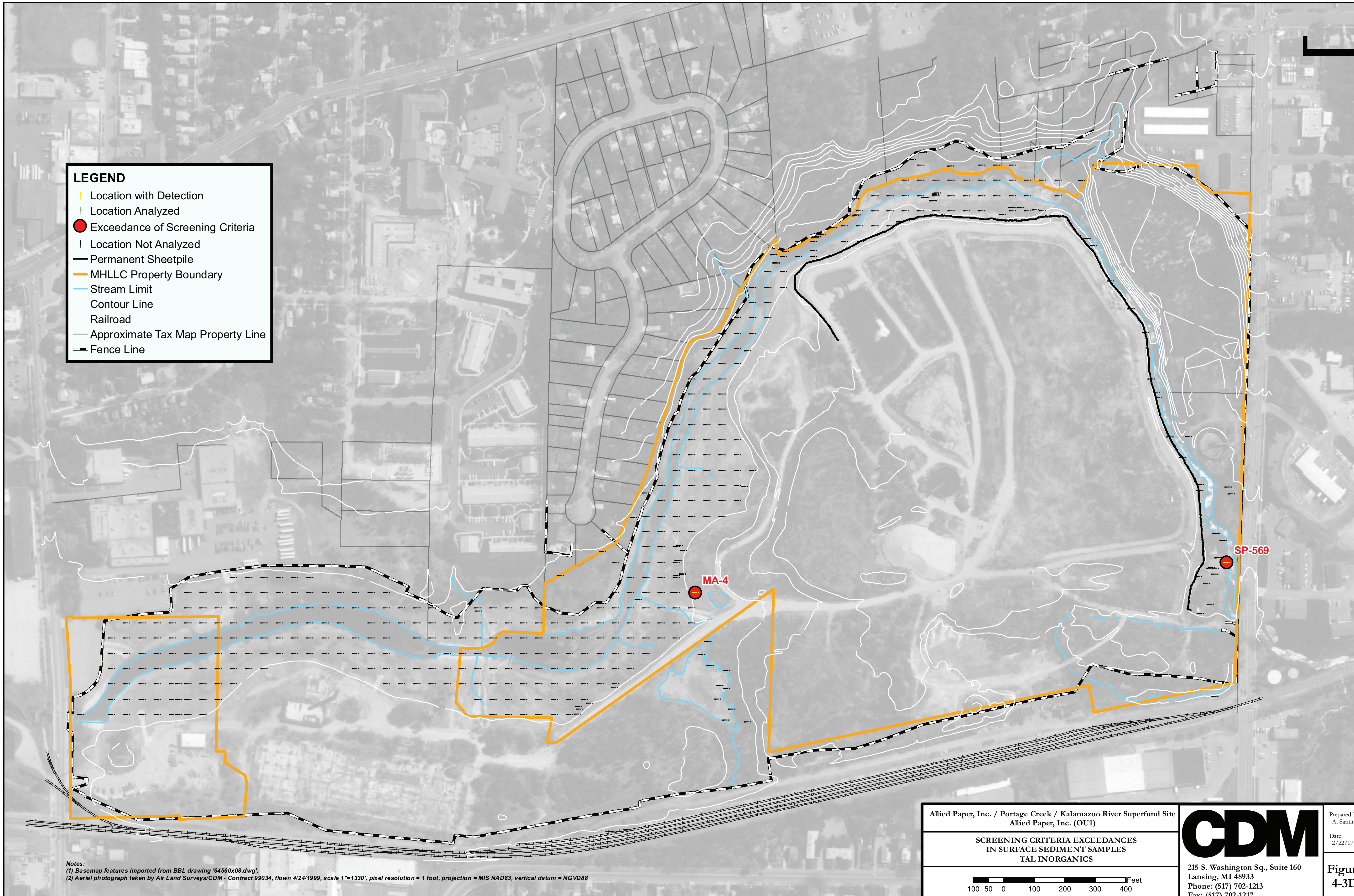
SCREENING CRITERIA EXCEEDANCES
IN SURFACE SEDIMENT SAMPLES
TCL SVOC

CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By: A. Santini

Date: 2/22/07

Figure 4-3C



Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN SURFACE SEDIMENT SAMPLES
TAL INORGANICS

CDM
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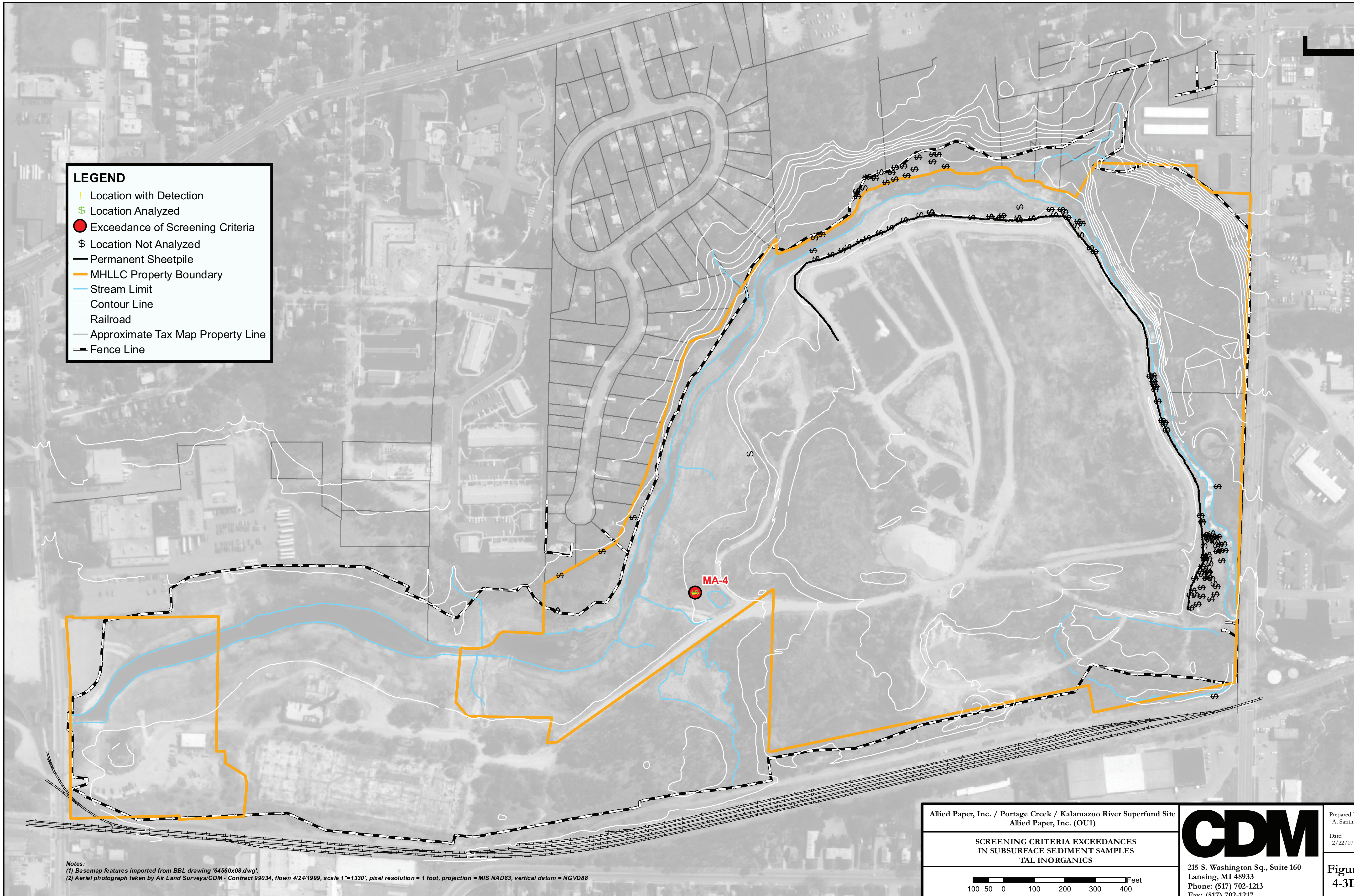
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By:
A. Santini

Date:
2/22/07

Figure
4-3D



Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN SUBSURFACE SEDIMENT SAMPLES
TAL INORGANICS

CDM

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Prepared By:
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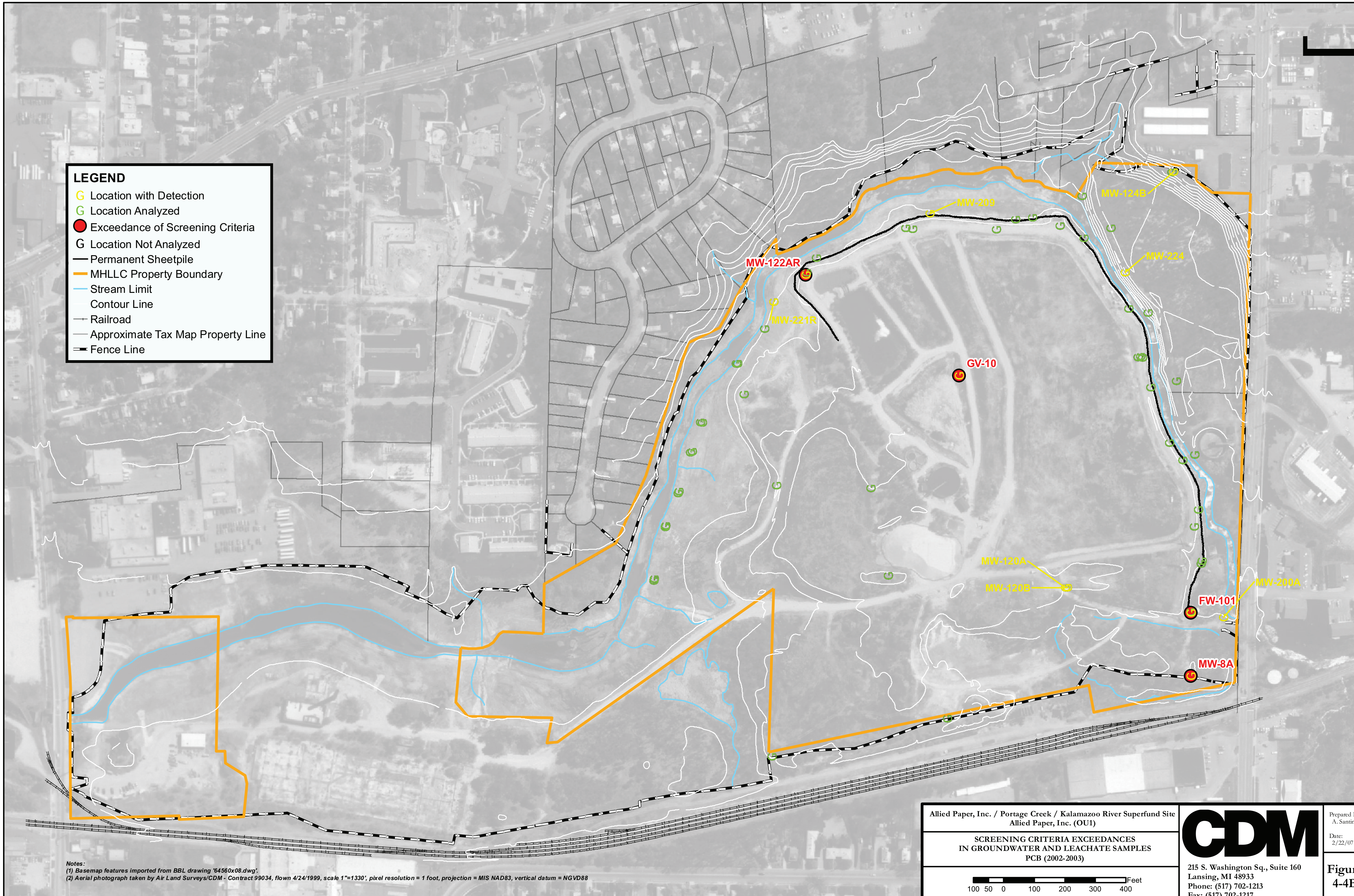
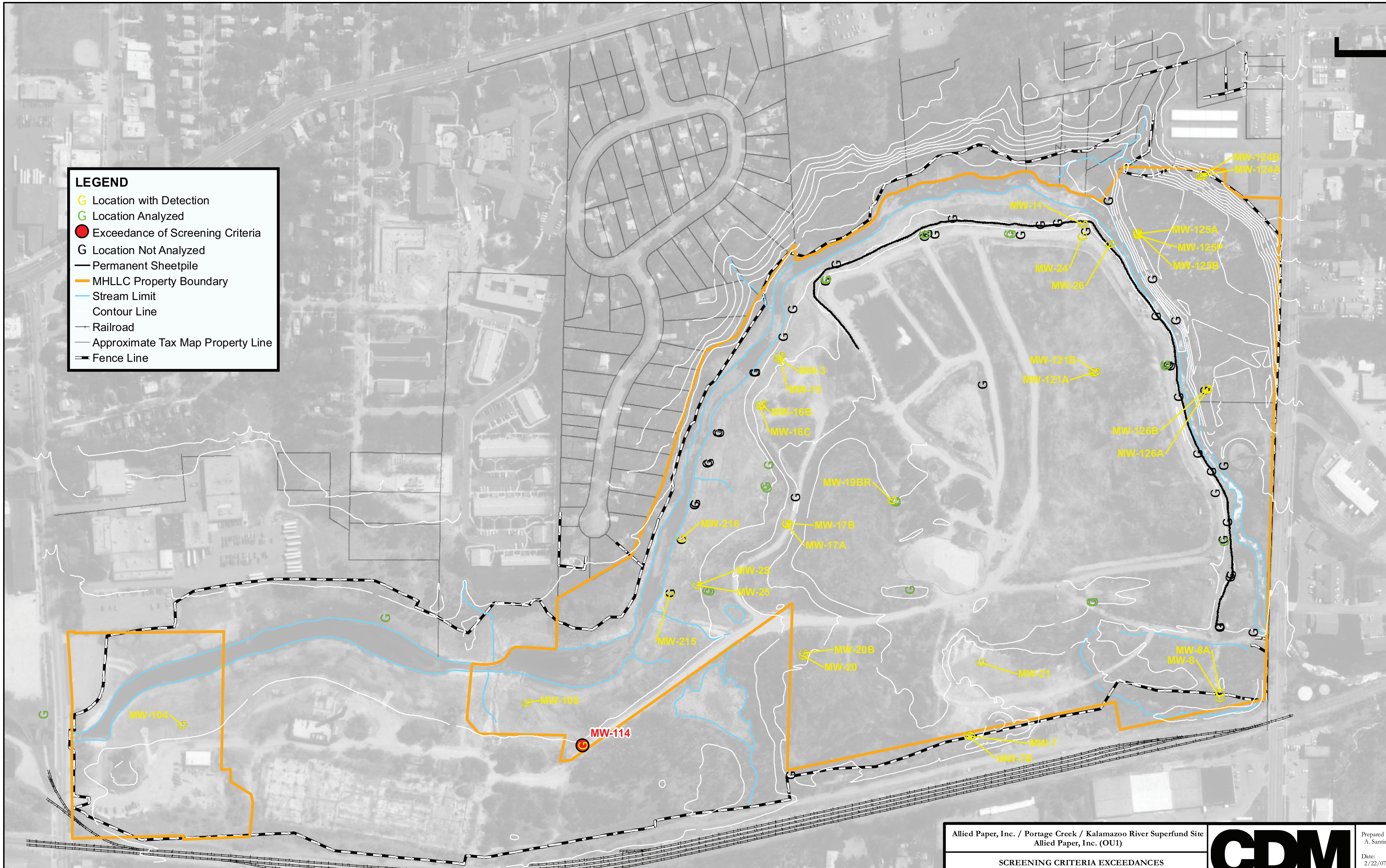
Date:
2/22/07

Figure 4-3E



LEGEND
Location with Detection
Location Analyzed
Exceedance of Screening Criteria
Location Not Analyzed
Permanent Sheetpile
MHLLC Property Boundary
Stream Limit
Contour Line
Railroad
Approximate Tax Map Property Line
Fence Line
MW-122AR
MW-209
MW-124B
MW-224
MW-221R
GV-10
MW-120A
MW-120B
MW-200A
FW-101
MW-8A
Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88
Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)
SCREENING CRITERIA EXCEEDANCES
IN GROUNDWATER AND LEACHATE SAMPLES
PCB (2002-2003)
100 50 0 100 200 300 400 Feet
CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217
Prepared By: A. Santini
Date: 2/22/07
Figure 4-4B



Notes:
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(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN GROUNDWATER AND LEACHATE SAMPLES
TCL - VOC

Feet
100 50 0 100 200 300 400

CDM

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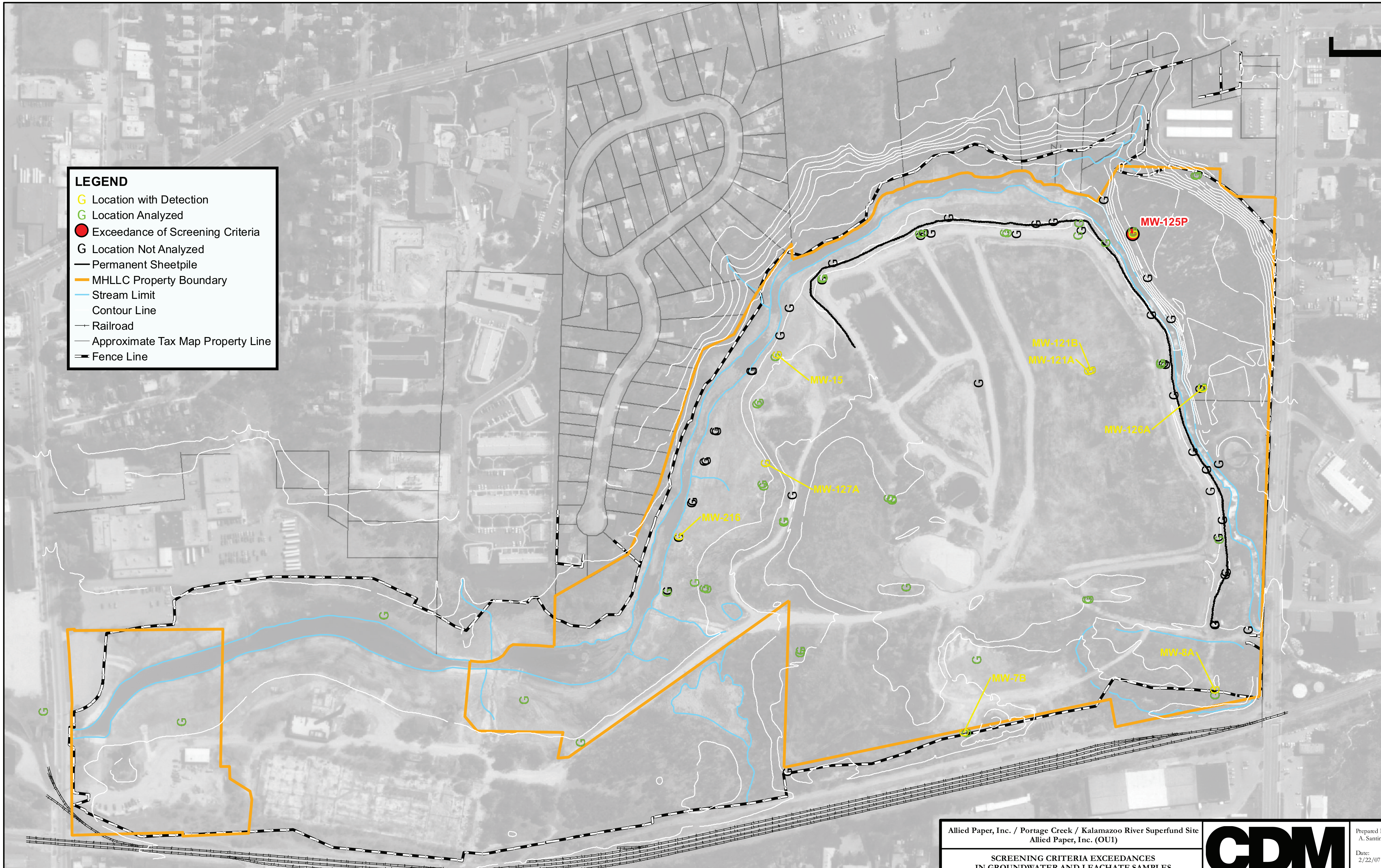
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By:
A. Santini

Date:
2/22/07

Figure
4-4C



Notes:
(1) Basemap features imported from BBL drawing '64560x08.dwg'.
(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

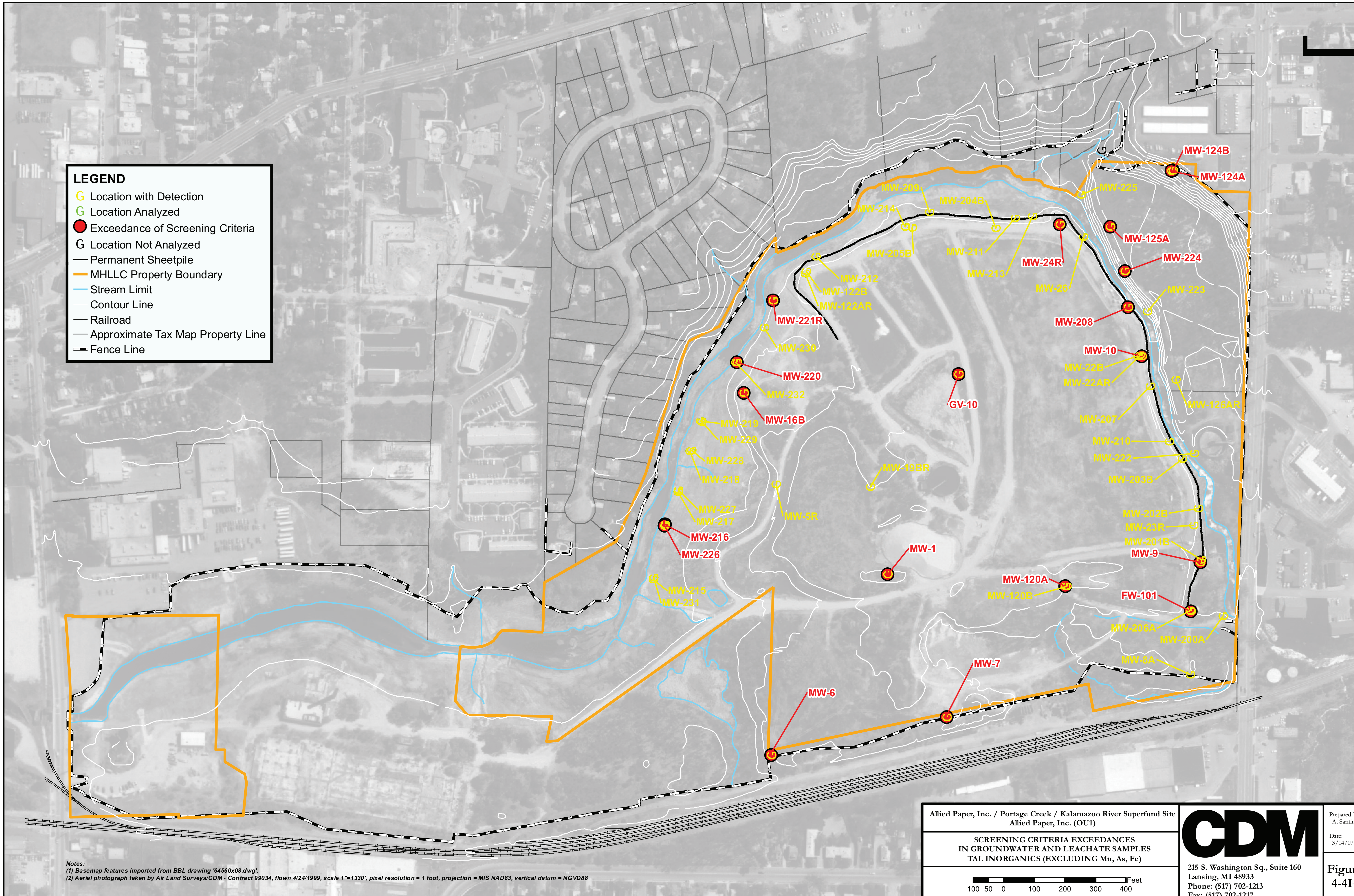
Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN GROUNDWATER AND LEACHATE SAMPLES
TCL - SVOC

CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By: A. Santini
Date: 2/22/07

Figure 4-4D



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(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

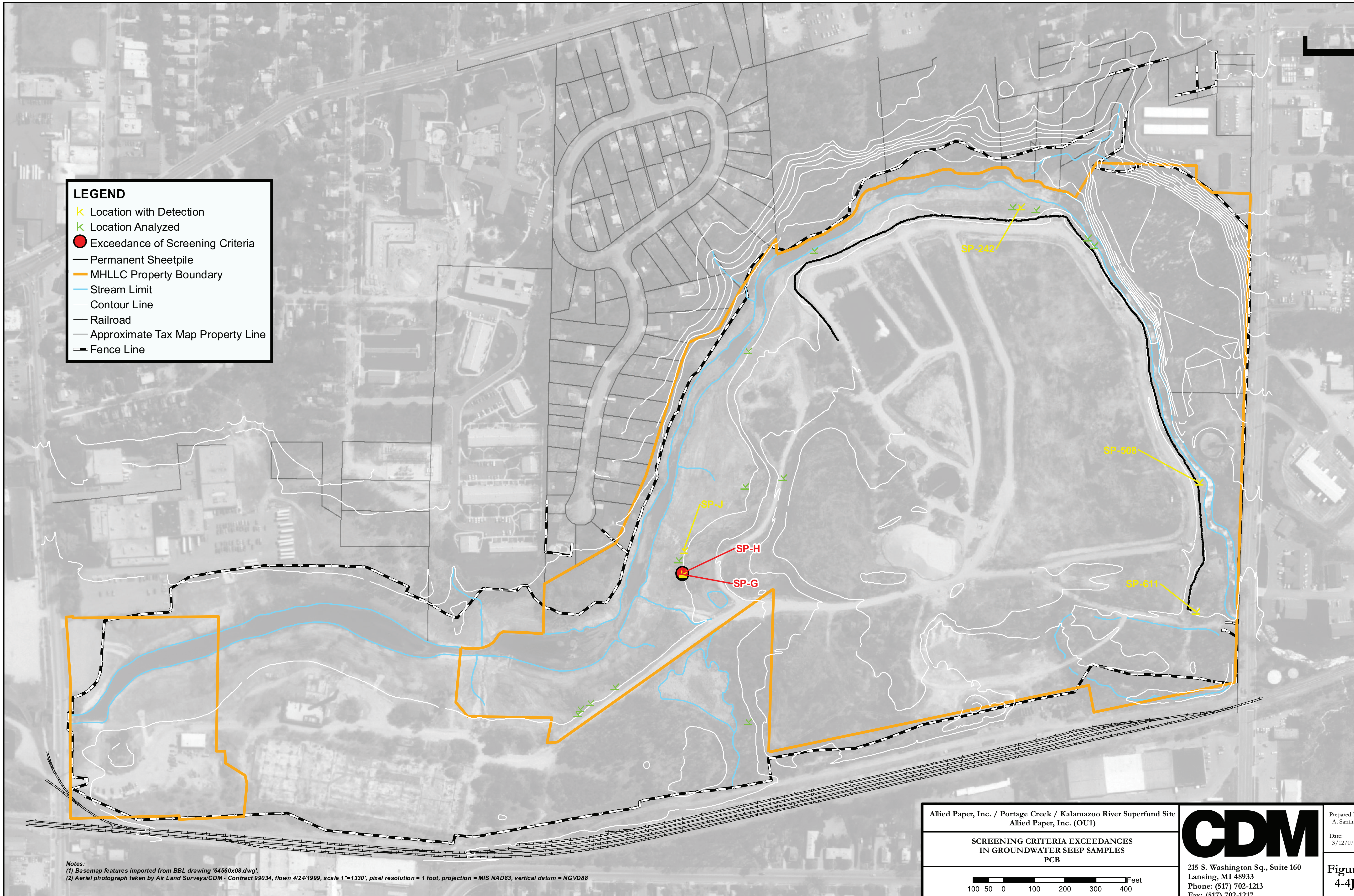
SCREENING CRITERIA EXCEEDANCES
IN GROUNDWATER AND LEACHATE SAMPLES
TAL INORGANICS (EXCLUDING Mn, As, Fe)

CDM
215 S. Washington Sq., Suite 160
Lansing, MI 48933
Phone: (517) 702-1213
Fax: (517) 702-1217

Prepared By:
A. Santini

Date:
3/14/07

Figure
4-4H



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(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN GROUNDWATER SEEP SAMPLES
PCB

CDM

215 S. Washington Sq., Suite 160
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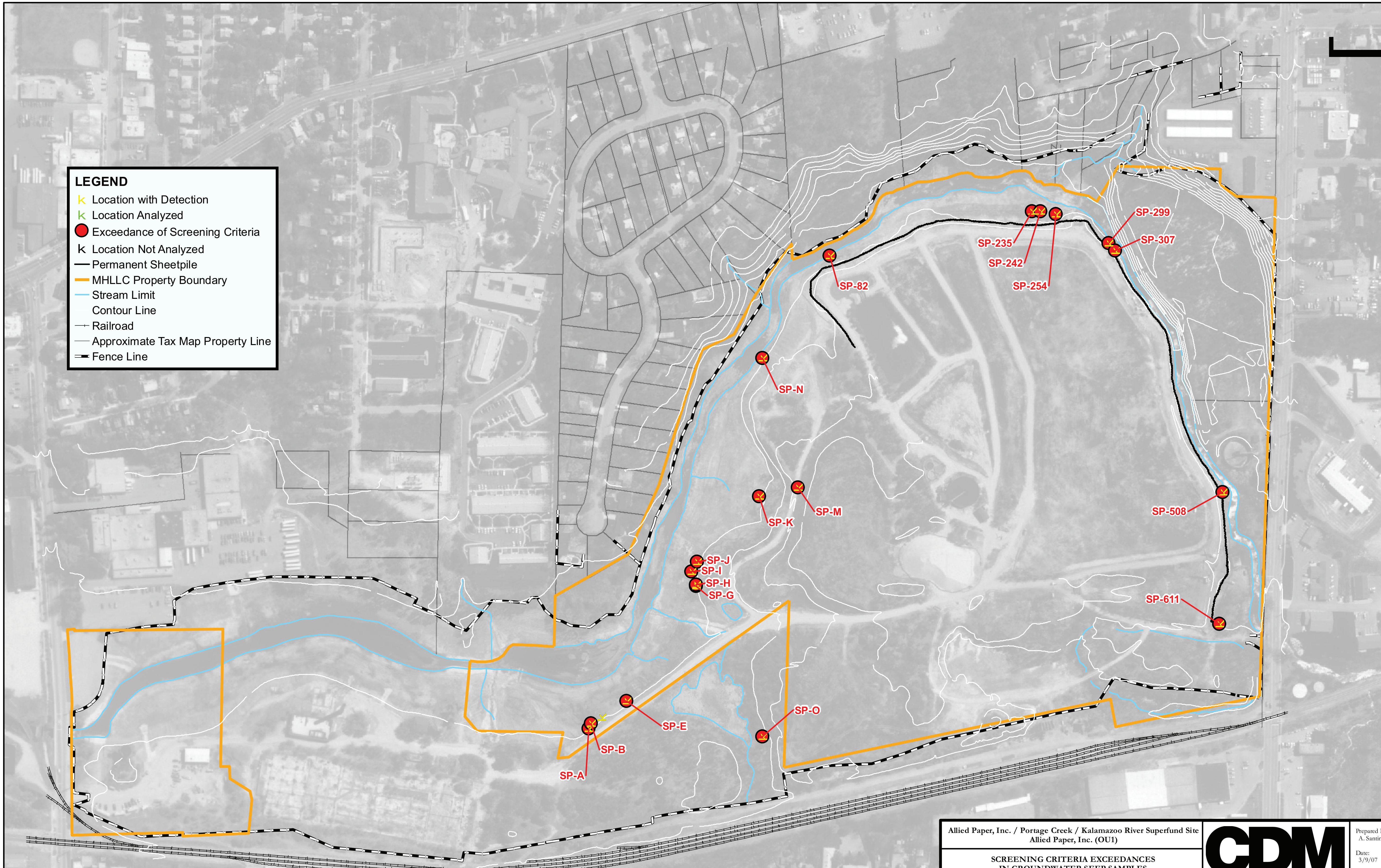
Prepared By:
A. Santini

Date:
3/12/07

Figure
4-4J



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(2) Aerial photograph taken by Air Land Surveys/CDM - Contract 99034, flown 4/24/1999, scale 1"=1330', pixel resolution = 1 foot, projection = MIS NAD83, vertical datum = NGVD88

Allied Paper, Inc. / Portage Creek / Kalamazoo River Superfund Site
Allied Paper, Inc. (OU1)

SCREENING CRITERIA EXCEEDANCES
IN GROUNDWATER SEEP SAMPLES
INORGANICS

CDM

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Figure
4-4K

TABLE 4-2A

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER
SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL SAMPLES
TOTAL PCB

Study Area	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
Former Operational Areas	Total PCB	55	110000	32/45	7
Former Bryant Mill Pond	Total PCB	330	3300	3/21	0
Residential - Commercial	Total PCB	66	761	9/23	0

TABLE 4-2C

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SUBSURFACE SOIL SAMPLES
TOTAL PCB

Study Area	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
Former Operational Areas	Total PCB	25	2500000	132/167	73
Former Bryant Mill Pond	Total PCB	86	86	1/3	0
Residential - Commercial	Total PCB	35	16960	11/62	1
Outside OU	Total PCB	31	31	1/2	0

TABLE 4-2E

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL SAMPLES
TCL VOC, TCL SVOC, TCL PESTICIDES, TAL INORGANICS, PCDD/PCDF

Parameter Group	Parameter	Minimum Detected Concentratio (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
VOCs					
	2-Butanone	130	140	2/3	0
	Acetone	460	460	2/3	0
SVOCs					
	2-Methylnaphthalene	112	214	2/3	0
	Chrysene	407	407	1/3	0
	Phenanthrene	143	206	2/3	0
	4-Methylphenol	233	319	2/3	0
Pesticides					
	P,P'-DDE	3.39	3.39	1/1	0
	P,P'-DDT	5.76	5.76	1/1	0
Inorganics					
	aluminum	2000000	7500000	2/2	1
	Arsenic	7150	7150	1/1	1
	barium	15000	55100	2/2	0
	beryllium	180	180	1/2	0
	calcium	21400000	28000000	2/2	-
	Chromium	5700	21600	2/2	2
	Cobalt	2500	5010	2/2	0
	Copper	6800	13300	2/2	0
	Iron	7100000	16000000	2/2	1
	Lead	14000	41000	2/2	1
	magnesium	5230000	6800000	2/2	0
	manganese	180000	187000	2/2	0
	mercury	57.5	57.5	1/2	0
	Nickel	5400	10700	2/2	0
	potassium	230000	599000	2/2	-
	Sodium	78700	78700	1/1	0
	vanadium	7200	15300	2/2	0
	zinc	20000	38100	2/2	0
PCDD/PCDF					
	Total TCDD-Equivalent Concentration-1998	0.00022	0.181	8/8	1

TABLE 4-2G

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SUBSURFACE SOIL SAMPLES
TCL VOC, TCL SVOC, TCL PESTICIDES, TAL INORGANICS, PCDD/PCDF

Parameter Group	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
VOCs					
	acetone	3	3400	42/54	0
	2-butanone	7	2200	31/54	0
	carbon disulfide	1	78	29/54	0
	toluene	1	930	26/54	0
	xylenes	6	220	21/54	0
	benzene	2	67	9/54	0
	ethylbenzene	10	49	9/54	0
	4-methyl-2-pentanone	8	51	5/54	0
	2-hexanone	11	290	4/54	0
	methylene chloride	2	30	4/54	0
	chloroform	8	14	2/54	0
	tetrachloroethene	24	26	2/54	0
	1,1,1-trichloroethane	3	3	1/54	0
	1,2-dichloroethene	4	4	1/54	0
	carbon tetrachloride	3800	3800	1/54	1
	cis-1,3-dichloropropene	14	14	1/54	0
SVOCs					
	bis(2-ethylhexyl)phthalate	20	5400	28/54	0
	2-methylnaphthalene	38	21000	26/54	0
	phenanthrene	33	7200	17/54	1
	4-methylphenol	16	38000	17/52	12
	fluoranthene	40	450	9/54	0
	chrysene	24	200	5/54	0
	naphthalene	62	1000	5/54	1
	pyrene	38	360	5/54	0
	benzo(a)anthracene	52	210	3/54	0
	benzo(a)pyrene	32	170	3/54	0
	benzo(b)fluoranthene	45	140	3/54	0
	benzo(k)fluoranthene	29	170	3/54	0
	anthracene	31	94	2/54	0
	carbazole	21	70	2/54	0
	di-n-butylphthalate	49	1000	2/54	0
	fluorene	180	400	2/54	0
	benzo(g,h,i)perylene	28	28	1/54	0
	dibenzofuran	100	100	1/54	0
	pentachlorophenol	2800	2800	1/51	1
Pesticides					
	4,4-DDD	6.7	20	3/52	0
	4,4-DDE	2.3	420	10/52	0
	4,4-DDT	4.7	410	13/51	0
	aldrin	0.85	130	14/53	0
	alpha-BHC	9.3	9.3	1/54	0
	alpha-chlordane	8.1	8.1	1/48	0
	beta-BHC	9.1	9.1	1/49	0
	delta-BHC	6.9	43	2/46	0
	endosulfan I	4.3	4.5	2/54	0
	endrin aldehyde	40	84	3/54	0
	gamma-chlordane	5.6	34	3/45	0
Inorganics					
	aluminum	430000	16000000	55/55	26
	calcium	860000	140000000	55/55	-
	Chromium	2800	160000	55/55	53
	copper	1800	95000	55/55	23
	iron	820000	58000000	55/55	8
	manganese	8800	3200000	55/55	4
	vanadium	3700	39000	55/55	0
	magnesium	390000	65000000	53/55	13
	arsenic	510	44000	53/54	9
	lead	330	910000	52/52	20
	barium	6900	1000000	50/55	23
	nickel	2200	24000	50/55	1
	zinc	5700	550000	45/45	28
	cobalt	930	9400	44/55	6
	potassium	150000	1100000	33/55	0
	cyanide	70	110000	29/54	21
	mercury	60	5100	27/55	20
	beryllium	120	6700	24/55	0
	selenium	190	1200	18/55	10
	sodium	130000	1200000	15/55	0
	cadmium	500	2000	10/55	5
	antimony	6500	25000	7/55	7
	thallium	770	770	1/55	0

TABLE 4-3A

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER
SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SEDIMENT SAMPLES
TOTAL PCB

Study Area	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
Former Operational Areas	Total PCB	27	12296	25/44	15
Former Bryant Mill Pond	Total PCB	62	12000	65/434	43
Former Panelyte Property	Total PCB	73	5260	13/32	3
Residential - Commercial	Total PCB	49	1012	21/32	8

TABLE 4-3C

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SUBSURFACE SEDIMENT SAMPLES
TOTAL PCB

Study Area	Parameter	Minimum Detected Concentratio (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
Former Operational Areas	Total PCB	28	11440	47/142	26
Former Bryant Mill Pond	Total PCB	52	340	9/74	1
Residential - Commercial	Total PCB	418	16000	7/30	7

TABLE 4-3G

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN SUBSURFACE SEDIMENT SAMPLES
TCL VOC, TCL SVOC, TCL PESTICIDES, TAL INORGANICS, PCDD/PCDF

Parameter Group	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
Inorganics					
	aluminum	5000000	5000000	1/1	0
	barium	150000	150000	1/1	1
	beryllium	1700	1700	1/1	0
	calcium	12000000	12000000	1/1	-
	Chromium	22000	22000	1/1	1
	cobalt	5900	5900	1/1	0
	copper	150000	150000	1/1	1
	cyanide	170	170	1/1	0
	iron	13000000	13000000	1/1	1
	lead	66000	66000	1/1	1
	magnesium	4000000	4000000	1/1	0
	manganese	96000	96000	1/1	0
	mercury	350	350	1/1	1
	nickel	24000	24000	1/1	1
	potassium	420000	420000	1/1	-
	selenium	1800	1800	1/1	1
	silver	1500	1500	1/1	1
	sodium	180000	180000	1/1	0
	vanadium	19000	19000	1/1	0
	zinc	130000	130000	1/1	1

TABLE 4-4A

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN GROUNDWATER AND LEACHATE SAMPLES
TOTAL PCB - UNFILTERED AND FILTERED

Sample Year	Sample Type	Matrix	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
1993	Unfiltered	Groundwater	Total PCB	0.89	4.90	8/57	8
1995	Unfiltered	Groundwater	Total PCB	0.20	1.40	9/55	8
1997	Filtered	Groundwater	Total PCB	0.07	1.10	10/11	5
1997	Unfiltered	Groundwater	Total PCB	0.08	1.00	17/18	14
1998	Unfiltered	Groundwater	Total PCB	0.08	0.60	6/23	3
2002	Unfiltered	Leachate	Total PCB	0.85	2.50	2/2	2
2002	Unfiltered	Groundwater	Total PCB	0.03	0.55	13/83	6
2003	Unfiltered	Groundwater	Total PCB	0.09	0.19	4/50	0

TABLE 4-4B

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER
SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF SCREENING CRITERIA EXCEEDANCES IN GROUNDWATER AND LEACHATE SAMPLES
TOTAL PCB - UNFILTERED AND FILTERED

Sample Year	Sample Type	Study Area	Station ID	Sample ID	Data Source	Matrix	Parameter	Detected Concentration (ppb)	Screening Criteria Value (ppb)	Part 201 Guide Number	Screening Criteria Name
Former Operational Areas											
1993	Unfiltered	Former Operational Areas	MW-120B	A66019	Table4-3D(CD)	Groundwater	Total PCB	4.9	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1993	Unfiltered	Former Operational Areas	MW-121A	A66013	Table4-3D(CD)	Groundwater	Total PCB	2.5	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1993	Unfiltered	Former Operational Areas	MW-121B	A66014	Table4-3D(CD)	Groundwater	Total PCB	0.99	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1993	Unfiltered	Former Operational Areas	MW-22A	A66017	Table4-3D(CD)	Groundwater	Total PCB	2.7	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1993	Unfiltered	Former Operational Areas	MW-24	A66009	Table4-3D(CD)	Groundwater	Total PCB	0.89	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1993	Unfiltered	Former Operational Areas	MW-8A	A66052	Table4-3D(CD)	Groundwater	Total PCB	3.8	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-120B	A66134	Table4-3D(CD)	Groundwater	Total PCB	0.62	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-121A	A66131	Table4-3D(CD)	Groundwater	Total PCB	1.3	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-121B	A66132	Table4-3D(CD)	Groundwater	Total PCB	0.22	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-126A	A66152	Table4-3D(CD)	Groundwater	Total PCB	0.24	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-22A	A66106	Table4-3D(CD)	Groundwater	Total PCB	1.4	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-24	A66102	Table4-3D(CD)	Groundwater	Total PCB	0.32	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Operational Areas	MW-8A	A66144	Table4-3D(CD)	Groundwater	Total PCB	1	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Filtered	Former Operational Areas	MW-120B	A66171-F	TM7	Groundwater	Total PCB	0.26	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-120B-A	A66182	Table4-3D(CD)	Groundwater	Total PCB	0.41	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-120B-A	A66183	Table4-3D(CD)	Groundwater	Total PCB	0.42	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-120B-B	A66184	Table4-3D(CD)	Groundwater	Total PCB	0.39	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-120B-C	A66185	Table4-3D(CD)	Groundwater	Total PCB	0.39	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Filtered	Former Operational Areas	MW-121A	A66172-F	TM7	Groundwater	Total PCB	1.1	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-121A	A66172	Table4-3D(CD)	Groundwater	Total PCB	1	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-121B	A66173	Table4-3D(CD)	Groundwater	Total PCB	0.28	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-121B-A	A66186	Table4-3D(CD)	Groundwater	Total PCB	0.3	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-121B-B	A66187	Table4-3D(CD)	Groundwater	Total PCB	0.29	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-121B-C	A66188	Table4-3D(CD)	Groundwater	Total PCB	0.25	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-126A	A66174	Table4-3D(CD)	Groundwater	Total PCB	0.26	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-126A	A66175	Table4-3D(CD)	Groundwater	Total PCB	0.28	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Filtered	Former Operational Areas	MW-22A	A66176-F	TM7	Groundwater	Total PCB	0.34	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-22A	A66176	Table4-3D(CD)	Groundwater	Total PCB	0.99	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Filtered	Former Operational Areas	MW-8A	A66179-F	TM7	Groundwater	Total PCB	0.42	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Operational Areas	MW-8A	A66179	Table4-3D(CD)	Groundwater	Total PCB	0.71	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1998	Unfiltered	Former Operational Areas	MW-122AR	A66193	Table4-3D(CD)	Groundwater	Total PCB	0.6	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1998	Unfiltered	Former Operational Areas	MW-122AR	A66208	Table4-3D(CD)	Groundwater	Total PCB	0.33	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1998	Unfiltered	Former Operational Areas	MW-122AR	A66253	Table4-3D(CD)	Groundwater	Total PCB	0.44	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	FW-101	A66332	Table4-3D(CD)	Groundwater	Total PCB	0.4	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	GV-10	A66357	Table4-3D(CD)	Leachate	Total PCB	2.5	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	GV-10	AF10752	Appendix MDEQ B	Leachate	Total PCB	0.847	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	MW-122AR	AF10820	Appendix MDEQ B	Groundwater	Total PCB	0.3822	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	MW-206P/FW-101	AF09885	Appendix MDEQ B	Groundwater	Total PCB	0.246	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	MW-8A	A66343	Table4-3D(CD)	Groundwater	Total PCB	0.33	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	MW-8A	A66358	Table4-3D(CD)	Groundwater	Total PCB	0.28	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Operational Areas	MW-8A	AF10318	Appendix MDEQ B	Groundwater	Total PCB	0.549	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
Former Bryant Mill Pond											
1993	Unfiltered	Former Bryant Mill Pond	MW-25	A66027	Table4-3D(CD)	Groundwater	Total PCB	3	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1993	Unfiltered	Former Bryant Mill Pond	MW-5	A66046	Table4-3D(CD)	Groundwater	Total PCB	1.2	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1995	Unfiltered	Former Bryant Mill Pond	MW-5	A66112	Table4-3D(CD)	Groundwater	Total PCB	0.57	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Filtered	Former Bryant Mill Pond	MW-5	A66178-F	TM7	Groundwater	Total PCB	0.31	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
1997	Unfiltered	Former Bryant Mill Pond	MW-5	A66178	Table4-3D(CD)	Groundwater	Total PCB	0.29	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs

TABLE 4-4C

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER
SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN GROUNDWATER AND LEACHATE SAMPLES
TCL VOC, TCL SVOC, TCL PESTICIDES, TAL INORGANICS - UNFILTERED AND FILTERED

Sample Year	Sample Type	Matrix	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
VOCs							
1993	Unfiltered	Leachate	2-butanone	34	34	1/1	0
1993	Unfiltered	Leachate	benzene	1	1	1/1	0
1993	Unfiltered	Leachate	carbon disulfide	2	2	1/1	0
1993	Unfiltered	Leachate	ethylbenzene	2	2	1/1	0
1993	Unfiltered	Leachate	toluene	2	2	1/1	0
1993	Unfiltered	Leachate	xylenes	10	10	1/1	0
1993	Unfiltered	Groundwater	1,1,1-trichloroethane	3	3	2/57	0
1993	Unfiltered	Groundwater	benzene	1	2	7/57	0
1993	Unfiltered	Groundwater	methylene chloride	1	1	2/57	0
1993	Unfiltered	Groundwater	tetrachloroethene	2	13	3/57	1
1993	Unfiltered	Groundwater	toluene	1	7	6/57	0
2003	Unfiltered	Groundwater	acetone	6.7	10	3/3	0
SVOCs							
1993	Unfiltered	Leachate	4-Methylphenol	600	600	1/1	1
1993	Unfiltered	Groundwater	2-methylnaphthalene	0.6	0.6	1/57	0
1993	Unfiltered	Groundwater	diethyl phthalate	0.7	0.7	1/57	0
1993	Unfiltered	Groundwater	di-n-butylphthalate	1	1	1/57	0
1993	Unfiltered	Groundwater	naphthalene	1	1	1/57	0
1993	Unfiltered	Groundwater	phenol	0.8	0.8	1/57	0
1993	Unfiltered	Groundwater	Sum of 2- and 4-Methylpheno[1]	1.5	15	5/57	0
2003	Unfiltered	Groundwater	phenol	11	12	2/3	0
PESTICIDES							
1993	Unfiltered	Leachate	alpha-BHC	0.028	0.028	1/1	0
INORGANICS							
1993	Filtered	Leachate	Aluminum	1100	1100	1/1	1
1993	Filtered	Leachate	Arsenic	26	26	1/1	1
1993	Filtered	Leachate	Barium	230	230	1/1	0
1993	Filtered	Leachate	Calcium	130000	130000	1/1	-
1993	Filtered	Leachate	Chromium (total)	7.1	7.1	1/1	0
1993	Filtered	Leachate	Iron	86000	86000	1/1	1
1993	Filtered	Leachate	Magnesium	17000	17000	1/1	0
1993	Filtered	Leachate	Manganese	1900	1900	1/1	1
1993	Filtered	Leachate	Nickel	20	20	1/1	0
1993	Filtered	Leachate	Potassium	2600	2600	1/1	-
1993	Filtered	Leachate	Sodium	24000	24000	1/1	0
1993	Filtered	Leachate	Total dissolved solids (TDS)	259600	259600	1/1	0
1993	Filtered	Groundwater	Aluminum	45	56	2/57	1
1993	Filtered	Groundwater	Arsenic	1.2	160	48/57	31
1993	Filtered	Groundwater	Barium	54	930	57/57	0
1993	Filtered	Groundwater	Beryllium	0.32	0.32	2/57	0
1993	Filtered	Groundwater	Cadmium	3.6	4.8	4/56	2
1993	Filtered	Groundwater	Calcium	26000	300000	57/57	-
1993	Filtered	Groundwater	Chromium (total)	2.6	6.8	6/57	0
1993	Filtered	Groundwater	Cobalt	5.2	14	9/57	0
1993	Filtered	Groundwater	Iron	32	40000	57/57	50
1993	Filtered	Groundwater	Lead	0.85	2.5	14/57	0
1993	Filtered	Groundwater	Magnesium	2800	72000	57/57	0
1993	Filtered	Groundwater	Manganese	29	1700	57/57	52
1993	Filtered	Groundwater	Mercury	0.09	0.13	2/56	2
1993	Filtered	Groundwater	Nickel	4.2	130	37/57	2
1993	Filtered	Groundwater	Potassium	770	24000	53/57	0
1993	Filtered	Groundwater	Selenium	0.95	3.8	19/57	0
1993	Filtered	Groundwater	Sodium	5000	140000	57/57	2
1993	Filtered	Groundwater	Total dissolved solids (TDS)	107480	458830	57/57	0
1993	Filtered	Groundwater	Vanadium	7.3	7.3	1/57	1
1993	Filtered	Groundwater	Zinc	3.4	3300	51/55	22
1993	Unfiltered	Leachate	Aluminum	2000	2000	1/1	1
1993	Unfiltered	Leachate	Arsenic	27	27	1/1	1
1993	Unfiltered	Leachate	Barium	220	220	1/1	0
1993	Unfiltered	Leachate	Calcium	130000	130000	1/1	-
1993	Unfiltered	Leachate	Chromium (total)	9.3	9.3	1/1	0
1993	Unfiltered	Leachate	Iron	81000	81000	1/1	1
1993	Unfiltered	Leachate	Magnesium	17000	17000	1/1	0
1993	Unfiltered	Leachate	Manganese	1800	1800	1/1	1
1993	Unfiltered	Leachate	Mercury	0.08	0.08	1/1	1

TABLE 4-4C

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN GROUNDWATER AND LEACHATE SAMPLES
TCL VOC, TCL SVOC, TCL PESTICIDES, TAL INORGANICS - UNFILTERED AND FILTERED

Sample Year	Sample Type	Matrix	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
1993	Unfiltered	Leachate	Nickel	22	22	1/1	0
1993	Unfiltered	Leachate	Potassium	2700	2700	1/1	-
1993	Unfiltered	Leachate	Sodium	25000	25000	1/1	0
1993	Unfiltered	Leachate	Vanadium	5.1	5.1	1/1	1
1993	Unfiltered	Leachate	Zinc	250	250	1/1	1
1993	Unfiltered	Groundwater	Aluminum	50	1200	12/57	11
1993	Unfiltered	Groundwater	Arsenic	1.1	230	43/57	31
1993	Unfiltered	Groundwater	Barium	52	950	57/57	0
1993	Unfiltered	Groundwater	Beryllium	0.37	0.77	4/57	0
1993	Unfiltered	Groundwater	Calcium	26000	320000	57/57	-
1993	Unfiltered	Groundwater	Chromium (total)	2.5	37	19/57	5
1993	Unfiltered	Groundwater	Cobalt	5.5	9.2	3/57	0
1993	Unfiltered	Groundwater	Copper	4	6.6	4/57	0
1993	Unfiltered	Groundwater	Cyanide	2.8	73	6/56	4
1993	Unfiltered	Groundwater	Iron	79	41000	57/57	52
1993	Unfiltered	Groundwater	Lead	0.8	61	26/57	11
1993	Unfiltered	Groundwater	Magnesium	3700	72000	57/57	0
1993	Unfiltered	Groundwater	Manganese	29	1700	57/57	52
1993	Unfiltered	Groundwater	Mercury	0.07	1.4	3/56	3
1993	Unfiltered	Groundwater	Nickel	4.2	150	30/57	2
1993	Unfiltered	Groundwater	Potassium	1200	24000	55/57	0
1993	Unfiltered	Groundwater	Selenium	0.83	4.2	12/57	0
1993	Unfiltered	Groundwater	Sodium	4100	140000	57/57	1
1993	Unfiltered	Groundwater	Vanadium	4.6	9	2/57	2
1993	Unfiltered	Groundwater	Zinc	3.3	6900	53/55	26
2002	Unfiltered	Leachate	Aluminum	280	280	1/1	1
2002	Unfiltered	Leachate	Arsenic	110	110	1/1	1
2002	Unfiltered	Leachate	Barium	840	840	1/1	0
2002	Unfiltered	Leachate	Calcium	290000	290000	1/1	-
2002	Unfiltered	Leachate	Chromium (total)	16	16	1/1	1
2002	Unfiltered	Leachate	Cobalt	28	28	1/1	0
2002	Unfiltered	Leachate	Cyanide	12	12	1/1	1
2002	Unfiltered	Leachate	Iron	1700	1700	1/1	1
2002	Unfiltered	Leachate	Magnesium	14000	14000	1/1	0
2002	Unfiltered	Leachate	Manganese	42	42	1/1	0
2002	Unfiltered	Leachate	Mercury	0.18	0.18	1/1	1
2002	Unfiltered	Leachate	Nickel	280	280	1/1	1
2002	Unfiltered	Leachate	Potassium	12000	12000	1/1	-
2002	Unfiltered	Leachate	Selenium	4.8	4.8	1/1	0
2002	Unfiltered	Leachate	Sodium	17000	17000	1/1	0
2002	Unfiltered	Leachate	Vanadium	400	400	1/1	1
2002	Unfiltered	Groundwater	Aluminum	16	58	12/41	2
2002	Unfiltered	Groundwater	Arsenic	3.7	140	21/41	15
2002	Unfiltered	Groundwater	Barium	60	1100	41/41	1
2002	Unfiltered	Groundwater	Cadmium	0.37	2.7	4/41	0
2002	Unfiltered	Groundwater	Calcium	84000	360000	41/41	-
2002	Unfiltered	Groundwater	Chromium (total)	27	27	1/41	1
2002	Unfiltered	Groundwater	Cobalt	2.4	4.5	4/41	0
2002	Unfiltered	Groundwater	Copper	1.9	7.4	13/41	0
2002	Unfiltered	Groundwater	Cyanide	12	12	1/41	1
2002	Unfiltered	Groundwater	Iron	39	75000	40/41	39
2002	Unfiltered	Groundwater	Lead	1.3	2.7	2/41	0
2002	Unfiltered	Groundwater	Magnesium	27000	120000	41/41	0
2002	Unfiltered	Groundwater	Manganese	11	1600	40/41	38
2002	Unfiltered	Groundwater	Nickel	25	110	5/41	1
2002	Unfiltered	Groundwater	Potassium	1200	22000	41/41	-
2002	Unfiltered	Groundwater	Silver	1.7	1.7	1/41	1
2002	Unfiltered	Groundwater	Sodium	5000	200000	41/41	2
2002	Unfiltered	Groundwater	Vanadium	2	12	3/41	1
2002	Unfiltered	Groundwater	Zinc	6.9	5300	15/41	6
2003	Unfiltered	Groundwater	Aluminum	30	120	5/31	3
2003	Unfiltered	Groundwater	Arsenic	4.6	140	11/31	8
2003	Unfiltered	Groundwater	Barium	69	1700	31/31	3
2003	Unfiltered	Groundwater	Calcium	79000	290000	31/31	-
2003	Unfiltered	Groundwater	Chromium (total)	1.1	7.6	5/31	0
2003	Unfiltered	Groundwater	Cobalt	4.2	10	3/31	0
2003	Unfiltered	Groundwater	Copper	1.7	3.9	11/31	0
2003	Unfiltered	Groundwater	Cyanide	13	22	3/31	3
2003	Unfiltered	Groundwater	Iron	53	58000	29/31	25
2003	Unfiltered	Groundwater	Lead	1.5	6.3	8/31	1
2003	Unfiltered	Groundwater	Magnesium	11000	90000	31/31	0
2003	Unfiltered	Groundwater	Manganese	2.9	6200	31/31	28
2003	Unfiltered	Groundwater	Nickel	7.7	160	10/31	3
2003	Unfiltered	Groundwater	Potassium	910	17000	31/31	-
2003	Unfiltered	Groundwater	Sodium	1900	140000	31/31	2
2003	Unfiltered	Groundwater	Vanadium	3	4.4	5/31	0
2003	Unfiltered	Groundwater	Zinc	3.2	1400	12/31	1

[1] Screening criteria based on the sum of detected concentrations of 2-Methylphenol and 4-Methylpher

TABLE 4-4G

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF DETECTED CONCENTRATIONS IN GROUNDWATER SEEP SAMPLES
TOTAL PCB - UNFILTERED

Sample Year	Sample Type	Matrix	Parameter	Minimum Detected Concentration (ppb)	Maximum Detected Concentration (ppb)	Frequency of Detection	No. of Samples Exceeding Screening Criteria
2002	Unfiltered	Seep	Total PCB	0.05	2.9	8/42	4
2003	Unfiltered	Seep	Total PCB	0.01	1.9	8/29	2

TABLE 4-4H

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER
SUPERFUND SITE

ALLIED PAPER, INC. OPERABLE UNIT REMEDIAL INVESTIGATION REPORT
SUMMARY OF SCREENING CRITERIA EXCEEDANCES IN GROUNDWATER SEEP SAMPLES
TOTAL PCB - UNFILTERED

Sample Year	Sample Type	Study Area	Station ID	Sample ID	Data Source	Matrix	Parameter	Detected Concentration (ppb)	Screening Criteria Value (ppb)	Part 201 Guide Number	Screening Criteria Name
2002	Unfiltered	Former Bryant Mill Pond	SP-G	A66366	Table4-4D(CD)	Seep	Total PCB	0.87	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Bryant Mill Pond	SP-G	AF12701	Appendix MDEQ B	Seep	Total PCB	1.06	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Bryant Mill Pond	SP-H	A66367	Table4-4D(CD)	Seep	Total PCB	2.8	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2002	Unfiltered	Former Bryant Mill Pond	SP-H	AF12702	Appendix MDEQ B	Seep	Total PCB	2.91	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2003	Unfiltered	Former Bryant Mill Pond	SP-H	A66425	Table4-4D(CD)	Seep	Total PCB	1.9	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs
2003	Unfiltered	Former Bryant Mill Pond	SP-H	AG02465	Appendix MDEQ B	Seep	Total PCB	1.38	0.2	3	Groundwater Surface Water Interface Criteria & RBSLs

Appendix E
Allied Paper Landfill Hot Spot Analysis

Allied Paper Landfill
Kalamazoo, Michigan
Hotspot Analysis

Prepared by:
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22 January 2013

Introduction:

The FIELDS Group was asked to evaluate the likelihood of elevated PCB values, spatially, in the Allied Paper Landfill area. Several GIS and spatial statistical methods were used to evaluate the existence of elevated PCB values as well as the existence of hotspots. One caveat to the below findings is that these analyses are dependent on the data sets that were delivered to the Group via the USEPA's CH2MHill contractor and the MDEQ's CDM contractor.

The purpose of this study is to determine if hotspots of PCB contamination exist at Allied Landfill, Operable Unit 1 of the Allied Paper/Portage Creek/Kalamazoo River Superfund Site. If hotspots exist at Allied Landfill, then it would be possible to target these areas for removal and off-site treatment. The waste within Allied Landfill is primarily contaminated paper residuals, though certain subareas also contain some construction debris. During the Remedial Investigation for Allied Landfill, PCB concentrations above 500 ppm were detected a number of times within the waste. In a cursory review of the data, the locations of the elevated contamination appear to be somewhat scattered, though the majority of the elevated concentrations are found in the western portion of Allied Landfill. The aim of this study is to evaluate the data to determine the likelihood that hotspots exist at Allied Landfill.

In order to conduct this study, it is necessary to characterize what Superfund would consider a hotspot at Allied Landfill. The qualities that make up a hotspot are defined as:

- areas where the concentrations of contamination are orders of magnitude above the average landfill levels:
    - o As some EPA guidance recommends that material with PCB concentrations above 500ppm are subject to treatment, that value was used to evaluate hotspot existence.
- areas of clustered, elevated PCB concentrations, as defined above.
- areas of a size such that exposure to or release of the mass would be significant.

This study attempts to evaluate the existence of hot spots by first estimating the amount of material above 500ppm, and then looking at the likelihood that singule detections of PCBs above 500ppm are predictive of areas of similar PCB concentrations. Lastly, FIELDS evaluated the sampling density required to find hotspots of various sizes above 500ppm.

Methods:

Data Handling and Sub-setting

The following files were received from CH2MHill:

- MDEQ_B.xls.xls
- SEDSOIL_OU1.xlsx

And CDM, MDEQ's contractor provided the following file:

- Pre-TCRA_OU1.xlsx

The files from CH2MHill were brought into ArcGIS, saved as shapefiles, and then merged. The soil and sediment PCB values in this merged file were used for the below analyses.

The file from CDM was also brought into ArcGIS and saved as a shapefile. That file contains sediment PCB values for the former Bryan Mill Pond. These values were used as a possible representation of the PCB levels in the Allied Paper Landfill. (The sediment removal at Bryant Mill Pond was placed in the Allied Paper Landfill.)

Cumulative Density Functions (CDFs)

A cumulative density function (CDF) is a means of determining the proportion of all samples values above (or below) a given value. The statistical software, SAS, was used to generate CDFs for a series of cutoff values (i.e., greater than or equal to 50ppm, 100ppm, and 500ppm). As used in the below analysis, a CDF is a means to demonstrate the likelihood of finding a PCB value above a give cutoff value if more sampling were performed. For example, is the likelihood that a PCB value in the Allied Paper Landfill greater than or equal to 500ppm 1% or 10% or 50%? A CDF will answer this question.

And although aspatial, CDFs provide an estimate of the proportion of areal contamination assuming an unbiased dataset.

These CDFs will be performed on each of the above data sets as well as subsets of these data sets. For example, a CDF will be created for only PCBs in the former Bryant Mill Pond that were placed in the Allied Paper Landfill.

Data posting and Cluster Analysis

Data posting of PCB values was done using ArcGIS and earthVision software applications. earthVision was used to display these results in three dimensions and in true elevation. ArcGIS displayed these data in two dimensions for the maximum PCB value at each location. Additionally, for sample locations with a PCB value greater than or equal to 50ppm and 500ppm, respectively, all of the PCB values in that location (the sample core) were displayed in order to view PCB variability within a sample location (core).

ArcGIS' Cluster and Outlier Analysis tool "identifies those clusters of points with values similar in magnitude, and those clusters of points with very heterogeneous values" (ArcGIS Help). In other words, this analysis shows whether the data change together, spatially, at Allied Paper Landfill. The output from this analysis is the Local Moran's I. The output is grouped as follows:

- High-High is a cluster of high values;
- Low-Low is a cluster of low values;
- High-Low is a high value surrounded primarily by low values; and
- Low-High is a low value surrounded primarily by high values.

The Cluster and Outlier Analysis tool will help answer what is the likelihood that high PCB values are located near other high PCB values, i.e., a "hotspot".

Probability mapping

Probability mapping is a means of visualizing the likelihood of finding a selected contamination value over an area. The probabilities are determined by first converting the continuous contamination data to a binary value (0,1). In the analysis performed in this document, if a PCB value was 500ppm or greater, it was given the value of 1. If it was less than 500ppm, it was given a value of 0. These binary values were interpolated. Hence, the interpolated values will vary from 0 to 1. As such, they represent the probability of an area (volume in three dimensions) having a value of 500ppm or greater. These varying probabilities are displayed in a map.

Hotspot Sample Designs

Hotspot sample designs were created to provide an indication of the sampling intensity required to find hotspots of a given radius (diameter) with a given probability. The hotspot sampling algorithm makes no assumption as to what constitutes a high contamination value; the algorithm is based on the area of the hotspot, not its concentration value. The algorithm was developed by Singer and implemented in the FIELDS Tools software as well as the Visual Sample Plan (VSP) software. (The algorithm and code are discussed in Gilbert.) The FIELDS Tools were used to create a series of hotspot sample designs for various hotspot sizes.

Results and Discussion:

Cumulative Density Functions (CDFs)

Cumulative density functions (CDFs) are plots of the frequency of occurrence versus the values. They are essentially a cumulative histogram. These CDFs are a way to show the proportion (percentage) of concentration values above or below a cutoff value. Although CDFs give no sense of where one would find PCB values above a selected cutoff, e.g., 500ppm, they do provide the proportion of times one would find these values.

If one assumes that much of the existing waste material in the Allied Paper Landfill was from the former Bryant Mill Pond, the expected distribution of PCB values can be seen in Figures 1, 2, and 3. (The former Bryant Mill Pond PCB samples are shown in Figure 4.) Figure 1 shows the proportion of all samples that are greater than or equal to 50ppm. Figures 2 and 3 show these proportions for cutoffs of 100ppm and 500ppm, respectively. In sum, the percentage of PCB greater than or equal to 50ppm, 100ppm, and 500ppm are 33, 23, and 1.7, respectively. Hence, one would expect that for every 100 new samples collected, about two would have values of PCB greater than or equal to 500ppm.

Using PCB data contained in Tables 4-2 J and K (data from years 1991, 1993, 2000, 2001, 2002, and 2003) the percentages of PCBs greater than or equal to 50ppm, 100ppm, and 500ppm are 9.7, 6.4, and 1.8, respectively. (See Figure 5 for a display of the PCB values from Tables 4-2 J and K.) The CDFs are displayed in Figures 6, 7, and 8.

If only the data within the Allied Paper Landfill area are used (see Figure 9), 5.6%, 4.2%, and 1.4% of the PCB values area greater than or equal to 50ppm, 100ppm, and 500ppm, respectively (see Figures 10, 11, and 12.)

Again sub-setting only the Allied Paper Landfill for the western portion of the landfill (see Figure 13), gives percentages greater than or equal to 50ppm, 100ppm, and 500ppm of 14.7, 13.2, and 4.7. These CDFs are show in Figures 14, 15, and 16.

Cumulatively, these results demonstrate that the likelihood of finding PCB values greater than or equal to 500ppm range from 4.7% to 1.4%. Hence, for every 100 new samples collected, anywhere from five to as few as two samples would have PCB values greater than or equal to 500ppm. Using a cutoff value of 100ppm, that range is 23% to 4.2%. Again, for every 100 new samples collected, about 23 to 4 would have values of PCB greater than or equal to 100ppm.

Data posting and Cluster Analysis

A three-dimensional display of the PCB values in the Allied Paper Landfill and environs are shown in Figure 17. (Note that the Z-scale has been exaggerated to aid in viewing.) Viewing these data in two-dimension, using the maximum PCB value per location, is displayed in Figure 18. PCB values greater than or equal to 500ppm are dispersed although they are mostly in the southwestern corner of the landfill area. Viewing all of the PCB values in the Z-plane (within a single sample core) for only those sample locations with a PCB value of 500ppm or larger shows that there is a lot of variability in the PCB values for the different sample core intervals (see Figure 19). The range of PCB values within a sample core can vary by five orders of magnitude. For example, varying from 0.051ppm to 2,000ppm. Figure 20 shows these ranges only for sample cores with a PCB value greater than or equal to 50ppm. Taken together, these figures demonstrate the extreme variation in PCB levels which implies that finding large areas (i.e., hotspots) with a consistently high level of PCB is extremely unlikely, certainly within the Z-plane.

The spatial relationship of PCBs, in the X-Y plane, was evaluated using Local Moran's I in the ArcGIS software. Figure 21 shows the output from this analysis. Point locations in pink represent a cluster of high values (HH). Those points in orange represent a location with an elevated PCB value surrounded by mostly low values (HL). The remaining gray-colored points represent unclustered PCB values. Note that the locations indicated by HH are dispersed. From the standpoint of finding elevated areas, i.e., hotspots, this is unfortunate. However, one does not see sample locations with an HH in well sampled areas indicating that the likelihood of high PCB value clusters are unlikely.

Additionally, the spatial relationship of PCBs in Z-plane was evaluated using both the Global Moran's I (an indicator of spatial correlation) and Local Moran's I for five of the seven cores with a PCB value of 500 or greater (see Figure 19). The two cores not selected for analysis are the one with only surface and subsurface for the depth (see the bottom-most sample location in Figure 19) and the sample to the upper right with only two depth intervals (0-.5 and 20-22). The Global Moran's I found each of the five cores' PCB values along the Z-plane to be random, i.e., no spatial correlation. The Local Moran's I found that each of the five cores had no statistically significant clusters of PCB values within them, whether high PCB values or low PCB values.

Probability mapping

Figures 22-23 are maps of probability estimates based on the likelihood of finding PCB values greater than or equal to 500ppm. In probability mapping, one is trying to determine the likelihood that one would find a concentration value at or above a particular cutoff. In this case, the cutoff was 500ppm. Figure 22 shows the areas that have a 25% probability of finding a PCB value 500ppm or greater (see areas in blue). Other areas not in blue have less than a 25% chance of finding PCBs at a concentration of 500 ppm or greater. Therefore, hotspots do not appear on the map in these areas. Additionally, areas where no samples were taken also have less than a 25% chance, however as they are poorly sampled, an accurate probability value cannot be obtained. In Figure 23, the areas in green have a 50% chance of finding a PCB value 500ppm or greater. And in Figure 24, the barely visible orange areas have a 75% chance of finding a PCB value 500ppm or greater. As one increases the likelihood (probability value) of finding a PCB value greater than or equal to 500ppm, the area ("hotspot") gets smaller and smaller. In each figure the limitation is the lack of nearby data, nonetheless the figures demonstrate how unlikely finding hotspots for PCB values at or above 500ppm are based on the existing data.

<u>Hotspot Sample Designs</u>

The hotspot sampling algorithm, as implemented in the FIELDS Tools software, was used to create a series of sample designs (see Table I). Table I shows the number of sample locations and analyses for a desired (expected) hotspot size. An assumption is made that one wants to find a hotspot of a given size 95% of the time, meaning there is only a 5% chance (see "Probability of Missing Hotspot" in Table I) of missing it. For example, if an expected or desired hotspot is 100 feet (50-foot radius), one would need to sample 343 locations in order to not miss a hotspot of this size five percent of the time. And if one collected 10 intervals from each sample location, 3,430 laboratory analyses would result. Figures 25 through 27 show what these sample designs would like at Allied Paper Landfill for hotspots ranging from 50 to 400 feet. The number of sample locations becomes exceedingly high the smaller the hotspot one wants to find. For example, finding a hotspot of 25 feet would require 5,557 sample locations and 55,570 laboratory sample analyses if 10 intervals were collected from each sample location.

Summary:

This study found that the likelihood of finding hotspots, contiguous areas with elevated PCB values, is extremely small. Multiple spatial and statistical methods were employed to evaluate the existence of hotspots. These methods included cumulative density functions (CDFs), data posting, cluster analysis, probability mapping, and hotspot sample designs. None of these methods demonstrated the likelihood of finding hotspots of PCBs.

With probability mapping the data suggest the very likely limited extent, spatially, of hotspots. For example, even at a paltry probability of 50%, there were only four locations that met the criterion of having a single PCB value of 500ppm or greater. The probability mapping does not indicate the likelihood of a hotspot of this concentration value or greater. Instead, it provides the likelihood of finding at least one location with a PCB value at 500ppm or greater.

Examination of the range of PCB values within a sample core, i.e., in the Z-plane, demonstrated the extreme spatial variability of these values. PCBs in the Z-plane can vary by five orders of magnitude. For example, PCB values can vary from 0.051ppm to 2,000ppm within the same core. Additionally, spatial statistical methods used within cores found there were no statistically significant clusters of PCB values. Hence, hotspots within a core (along the Z-plane) are highly unlikely.

Perhaps most significantly, the cumulative distribution functions (CDFs) show that the proportion of elevated PCB values is quite low. And they are low even when sub-setting the PCB data for the most probable values within the landfill (e.g., former Bryant Mill Pond data only). The implication is that further sampling would likely find the same proportions and, hence, likely not find a significant number of clustered elevated PCB values, i.e., hotspots. For example, if the highest proportion of PCB values that are expected to be at or above 500ppm is less than 5%, then for every 100 samples, only 5 would meet this criterion. And if the assumption of hotspots of significant size were applied, then these 5 samples would all have to be contiguous. The probability of this occurring is incredibly unlikely.

If one were to assume hotspots of significant sized existed, the use of the hotspot sample design algorithm indicated the very large number of sample locations and analyses required to find hotspots of various sizes. For example, for a hotspot of diameter 25 feet, one would need to collect about 1,400 sample cores and submit approximately 14,000 samples for laboratory analysis.

It is important to point out that the hotspot sample design algorithm and spatial statistical techniques such as interpolations are based on the assumption that some process was responsible for the deposition of contaminant, e.g, from a spill, from a natural process. A landfill violates that assumption. Hence, it is not surprising that these techniques did not find a spatial relationship of elevated PCB levels with distance. In other words, PCBs in a landfill would be expected to exhibit a “salt and pepper” pattern, i.e., a more random spatial arrangement; finding large contiguous areas (i.e., hotspots) with a consistently high level of PCB, e.g., 500ppm, is exceedingly unlikely.

References:

ArcGIS software by ESRI, see (http://www.esri.com/software/arcgis)

earthVision software by Dynamic Graphics Incorporated, see (http://www.dgi.com/earthvision/evmain.html)

Gilbert, R.O., Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, New York, NY, 1987.

See Help documentation in the ArcGIS software, versions 9.x and 10.x.

Visual Sample Plan (VSP) software by Pacific Northwest National Laboratory, see (http://vsp.pnnl.gov/)

Contact:

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Cumulative Distribution Function of Bryant Mill Pond Detectable PCB Concentrations

Allied Paper

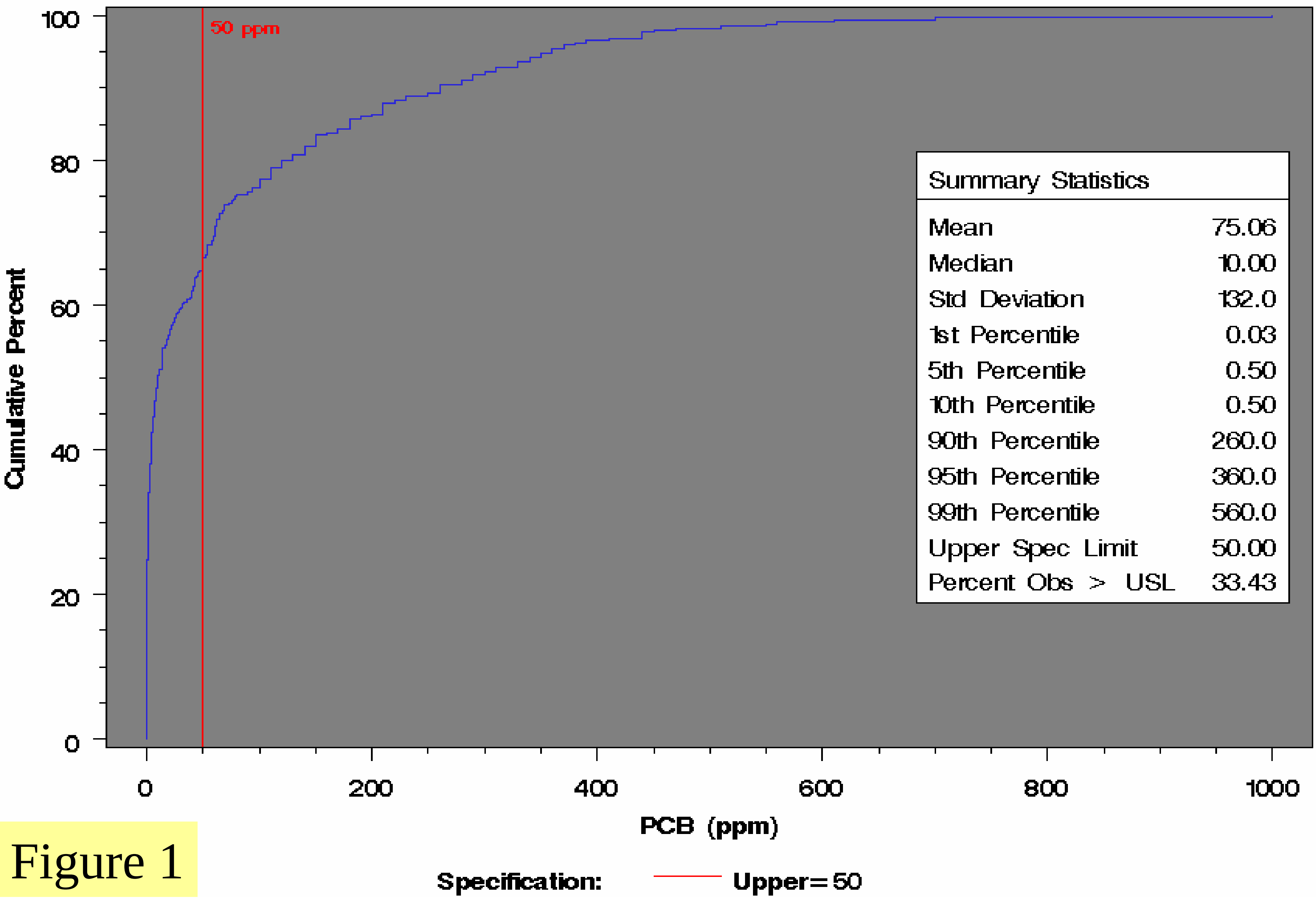


Figure 1

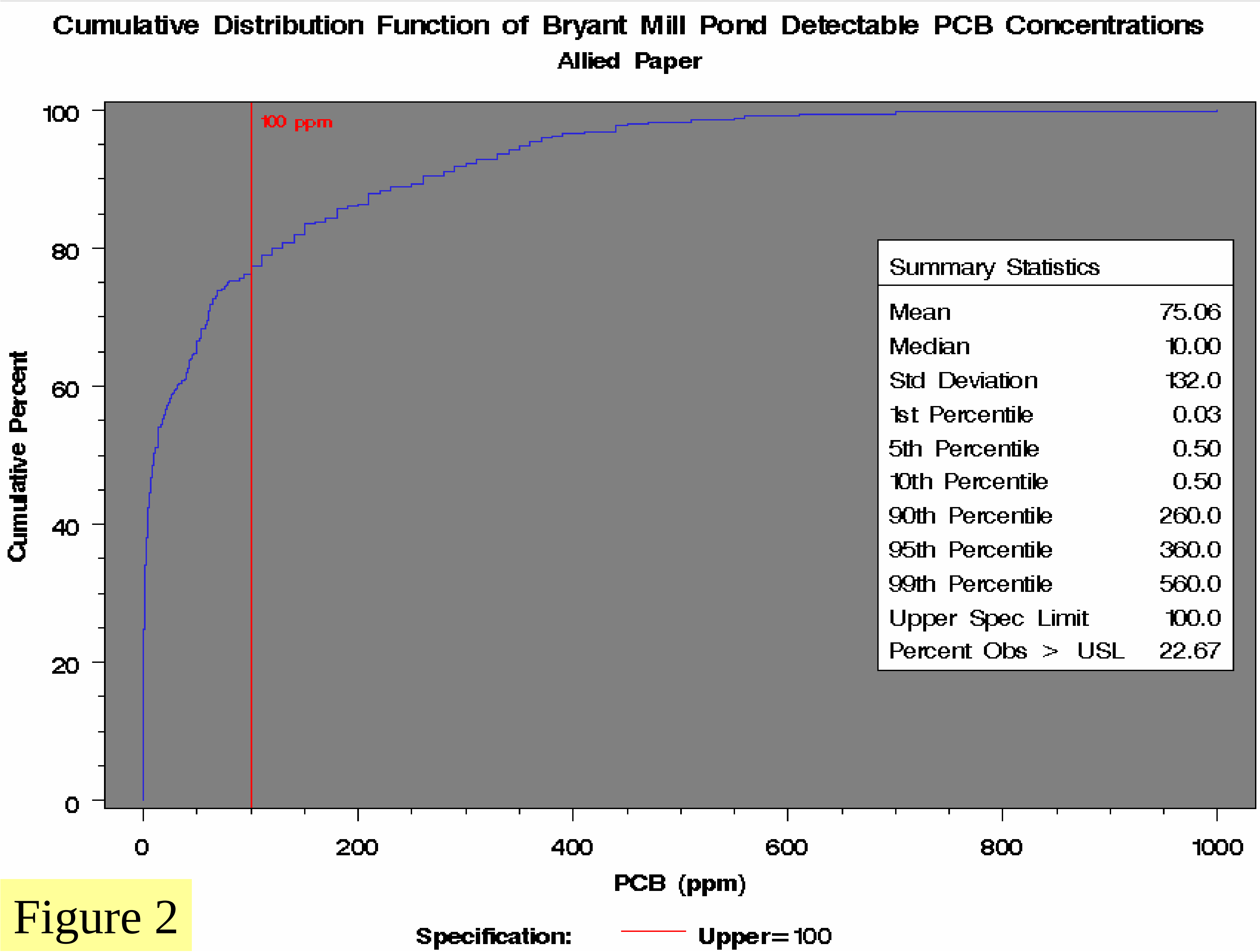

Cumulative Distribution Function of Bryant Mill Pond Detectable PCB Concentrations
Allied Paper
100 ppm
Cumulative Percent
0
20
40
60
80
100
0
200
400
600
800
1000
PCB (ppm)
Summary Statistics
Mean 75.06
Median 10.00
Std Deviation 132.0
1st Percentile 0.03
5th Percentile 0.50
10th Percentile 0.50
90th Percentile 260.0
95th Percentile 360.0
99th Percentile 560.0
Upper Spec Limit 100.0
Percent Obs > USL 22.67
Specification: Upper=100

Figure 2

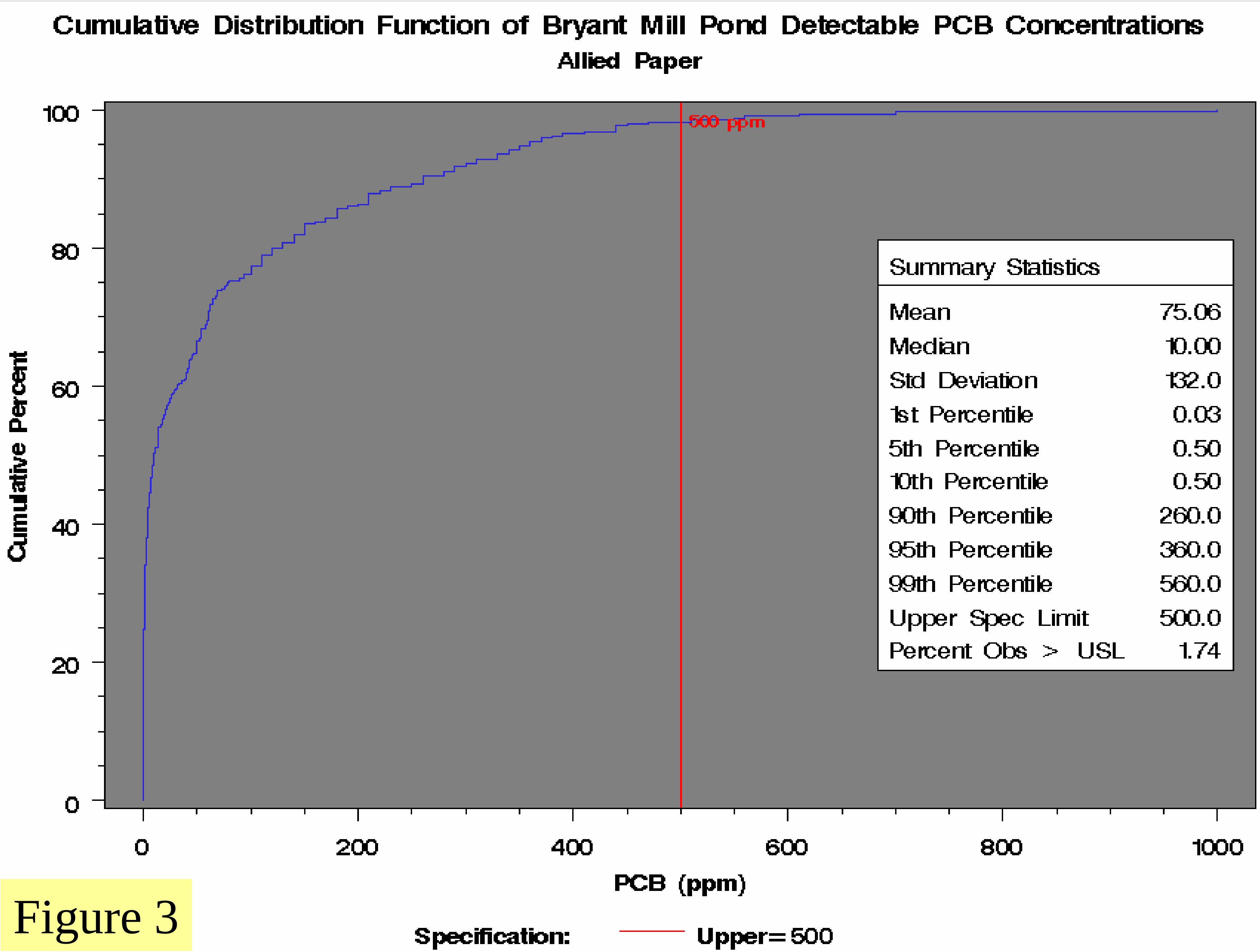

Cumulative Distribution Function of Bryant Mill Pond Detectable PCB Concentrations
Allied Paper
Cumulative Percent
0
20
40
60
80
100
0
200
400
600
800
1000
PCB (ppm)
500 ppm
Summary Statistics
Mean 75.06
Median 10.00
Std Deviation 132.0
1st Percentile 0.03
5th Percentile 0.50
10th Percentile 0.50
90th Percentile 260.0
95th Percentile 360.0
99th Percentile 560.0
Upper Spec Limit 500.0
Percent Obs > USL 1.74
Specification: Upper=500

Figure 3

Figure 4

Allied Paper - Bryant Mill Pond Detectable PCB Sample Locations

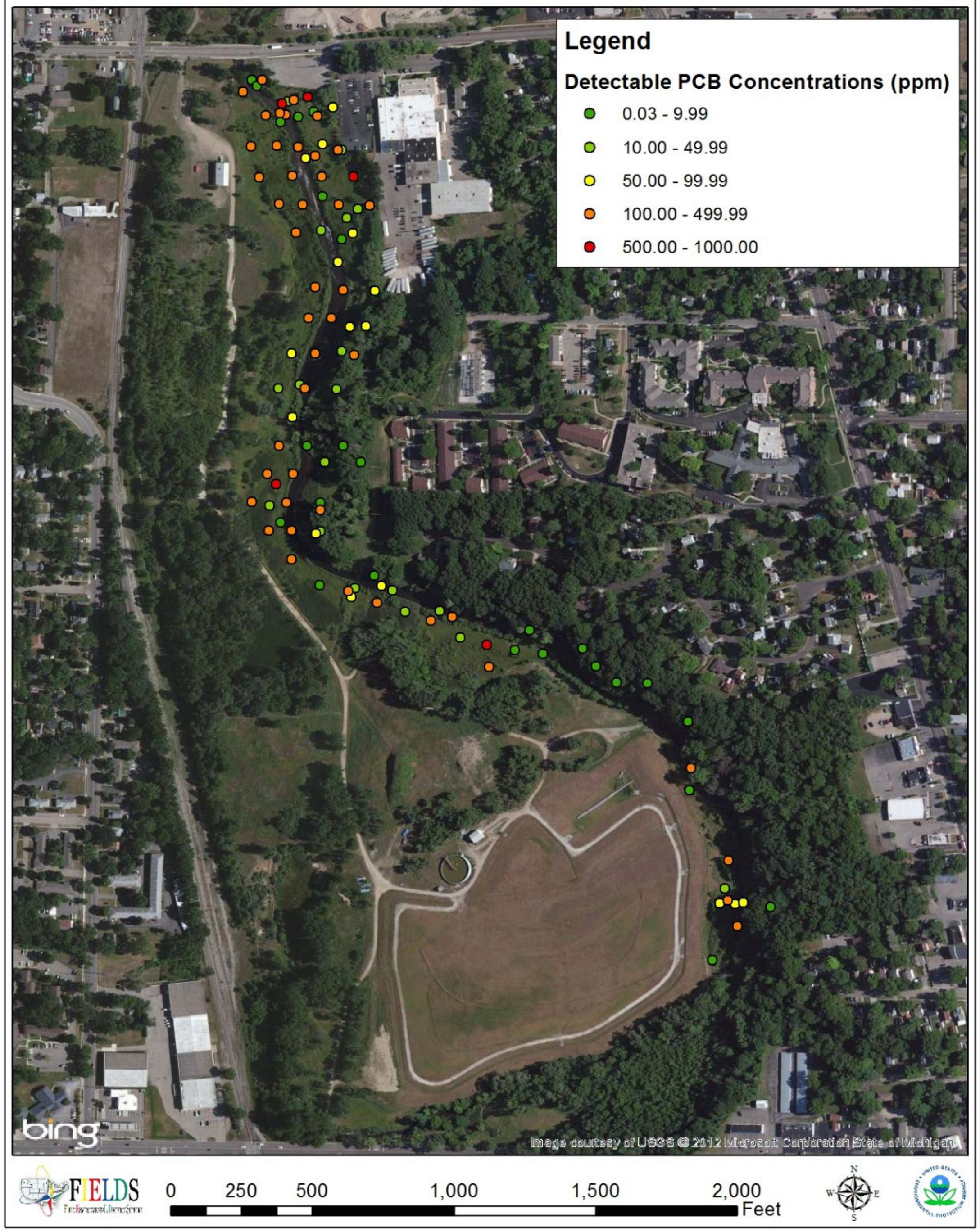


Figure 5

Allied Paper - PCB Sample Locations from Tables 4-2J and 4-2K Only
Legend
PCB Concentration (ppm)
0.02 - 9.99
10.00 - 49.99
50.00 - 99.99
100.00 - 499.99
500.00 - 2500.00
bing
FIELDS
0
250
500
1,000
1,500
2,000
Feet

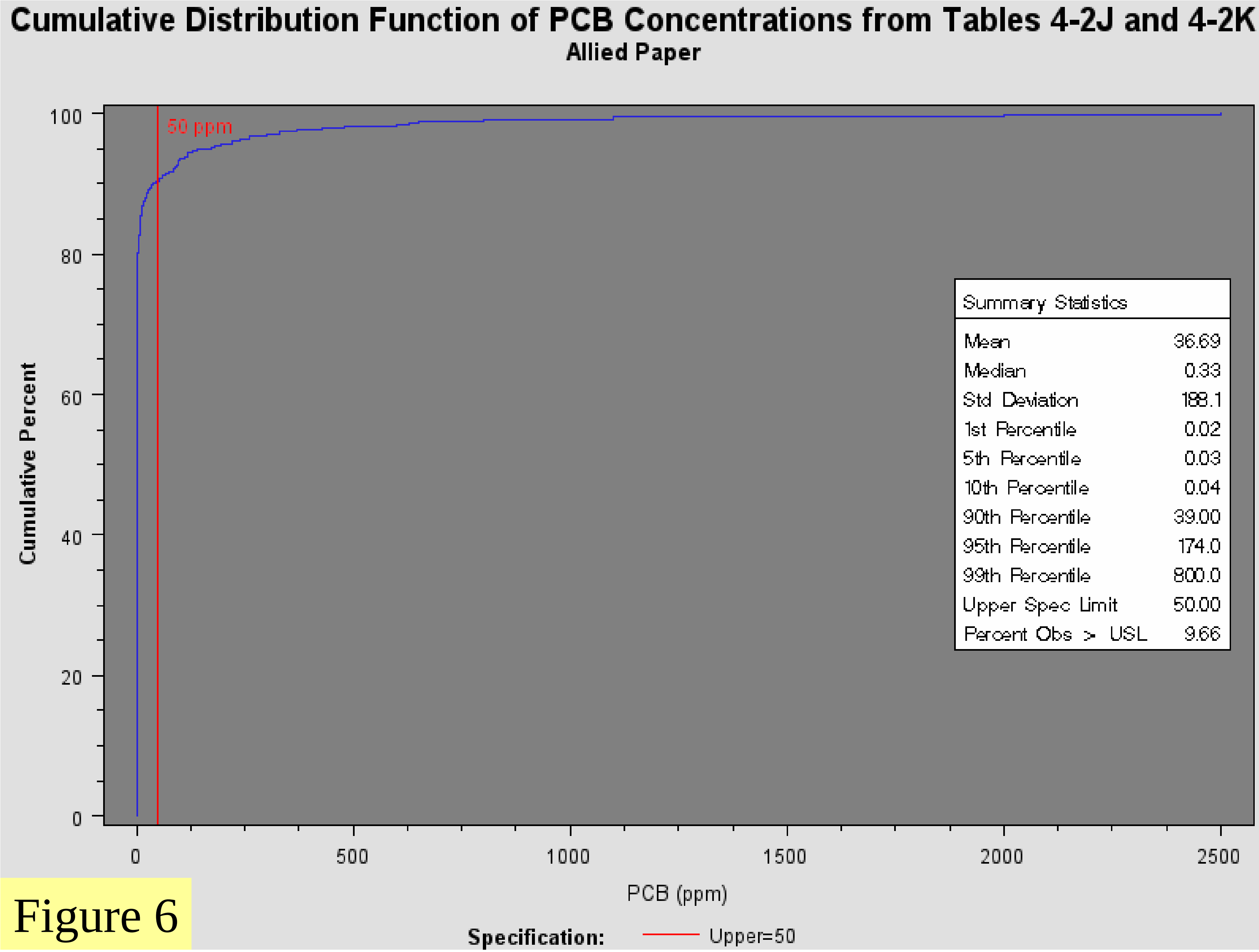

Cumulative Distribution Function of PCB Concentrations from Tables 4-2J and 4-2K
Allied Paper
Cumulative Percent
100
80
60
40
20
0
50 ppm
0
500
1000
1500
2000
2500
PCB (ppm)
Summary Statistics
Mean 36.69
Median 0.33
Std Deviation 188.1
1st Percentile 0.02
5th Percentile 0.03
10th Percentile 0.04
90th Percentile 39.00
95th Percentile 174.0
99th Percentile 800.0
Upper Spec Limit 50.00
Percent Obs > USL 9.66
Specification: Upper=50

Figure 6

Cumulative Distribution Function of PCB Concentrations from Tables 4—2J and 4—2K
Allied Paper

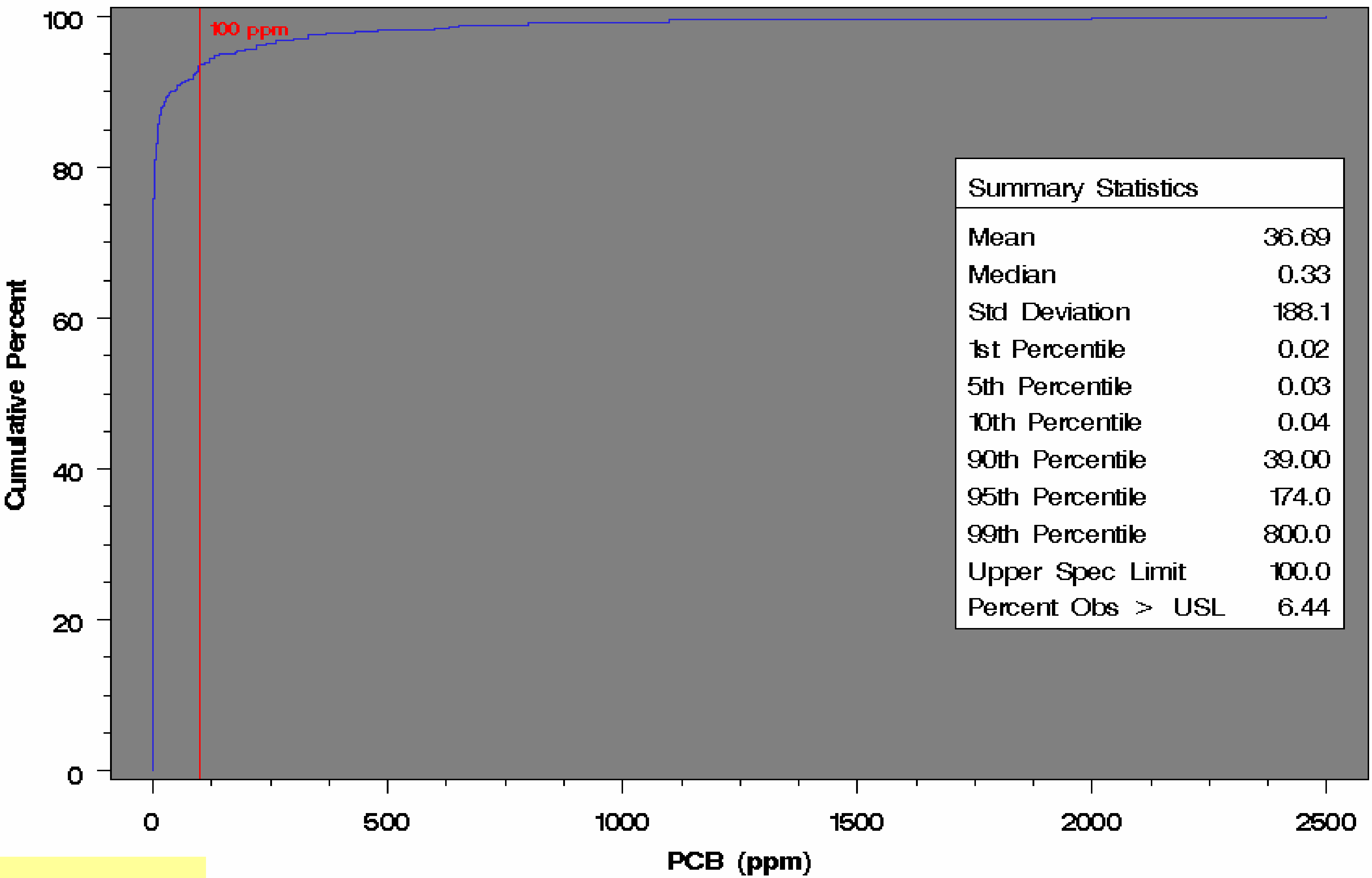


Figure 7

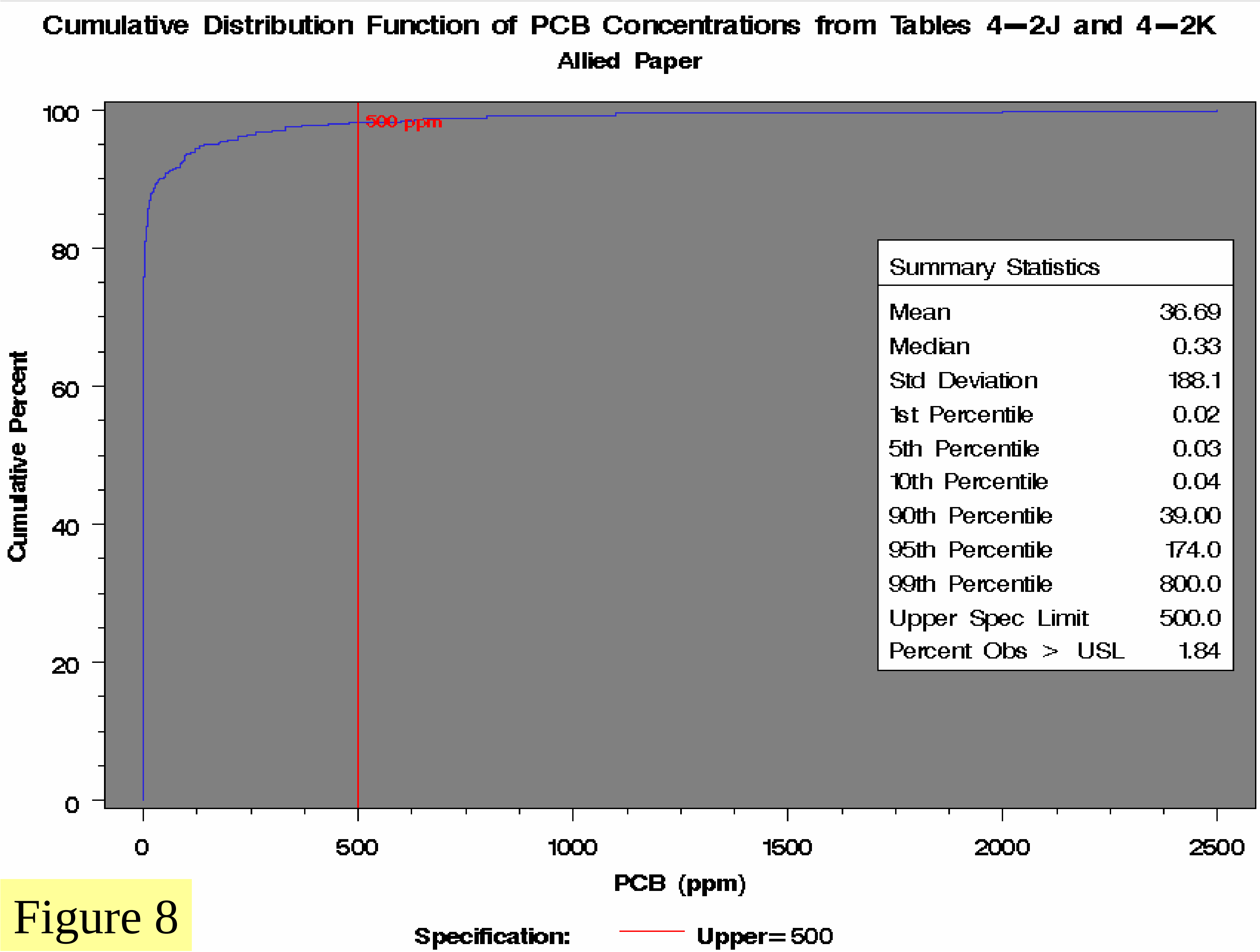
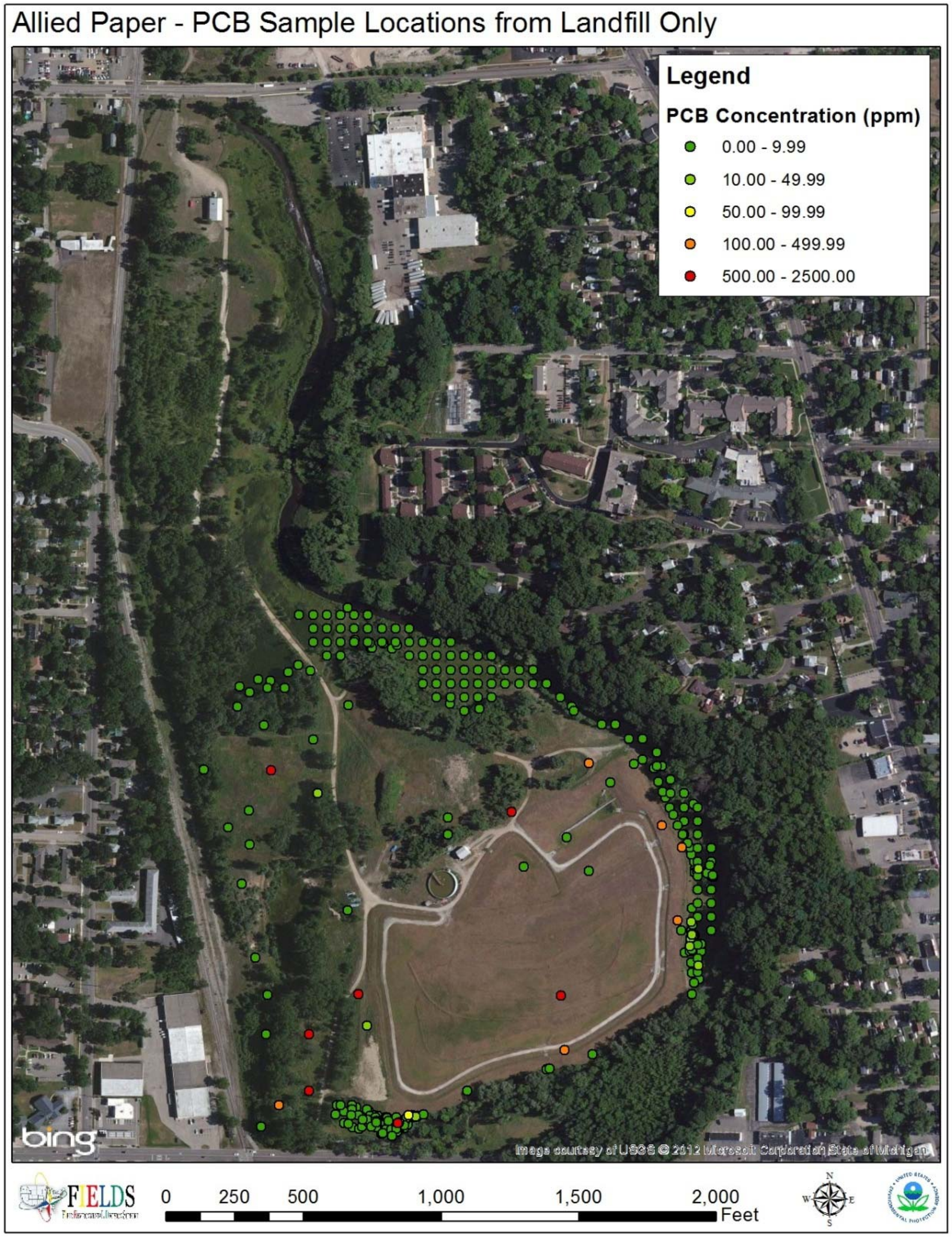
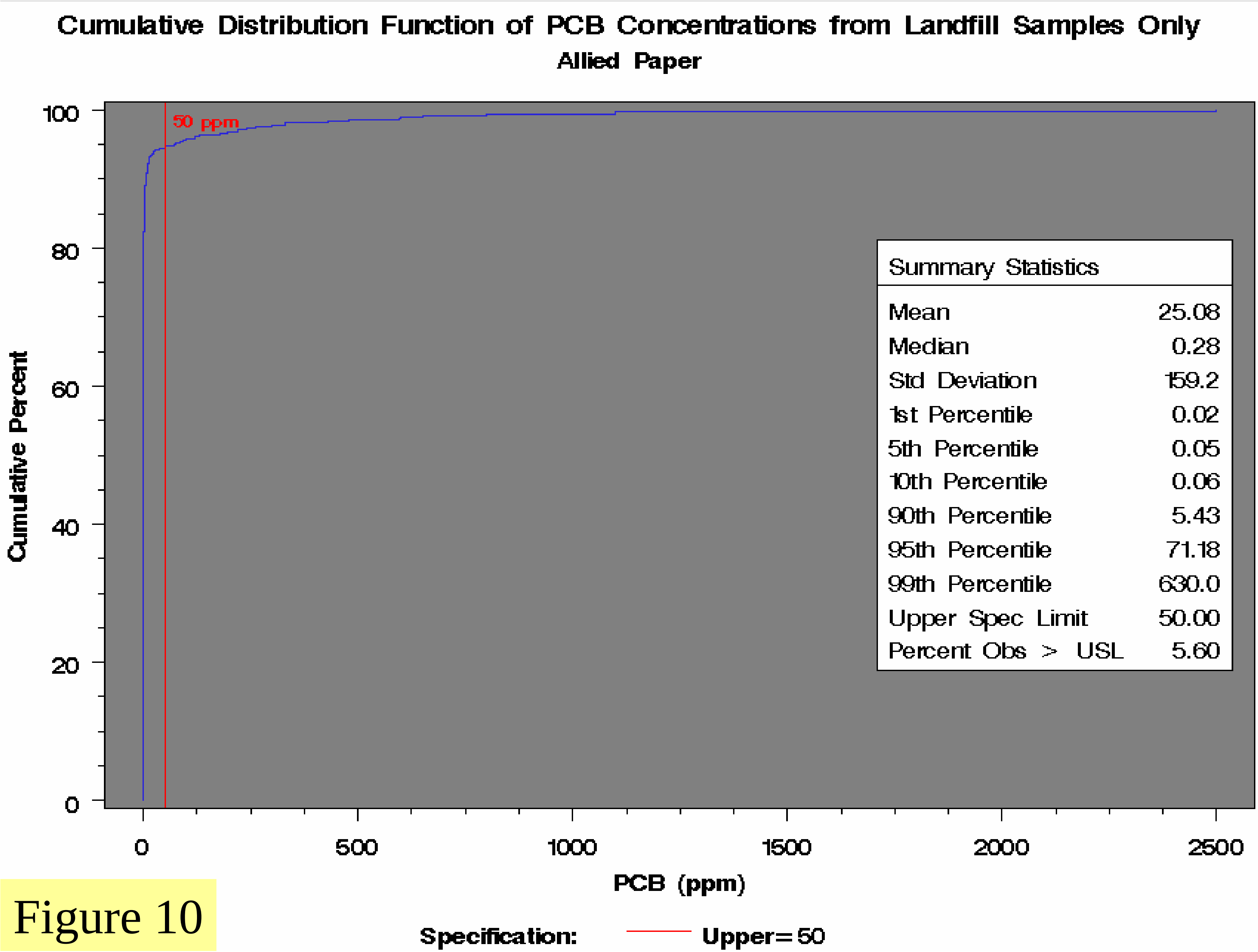

Cumulative Distribution Function of PCB Concentrations from Tables 4—2J and 4—2K
Allied Paper
Cumulative Percent
100
80
60
40
20
0
500 ppm
Summary Statistics
Mean 36.69
Median 0.33
Std Deviation 188.1
1st Percentile 0.02
5th Percentile 0.03
10th Percentile 0.04
90th Percentile 39.00
95th Percentile 174.0
99th Percentile 800.0
Upper Spec Limit 500.0
Percent Obs > USL 1.84
0
500
1000
1500
2000
2500
PCB (ppm)
Specification:
Upper=500

Figure 8

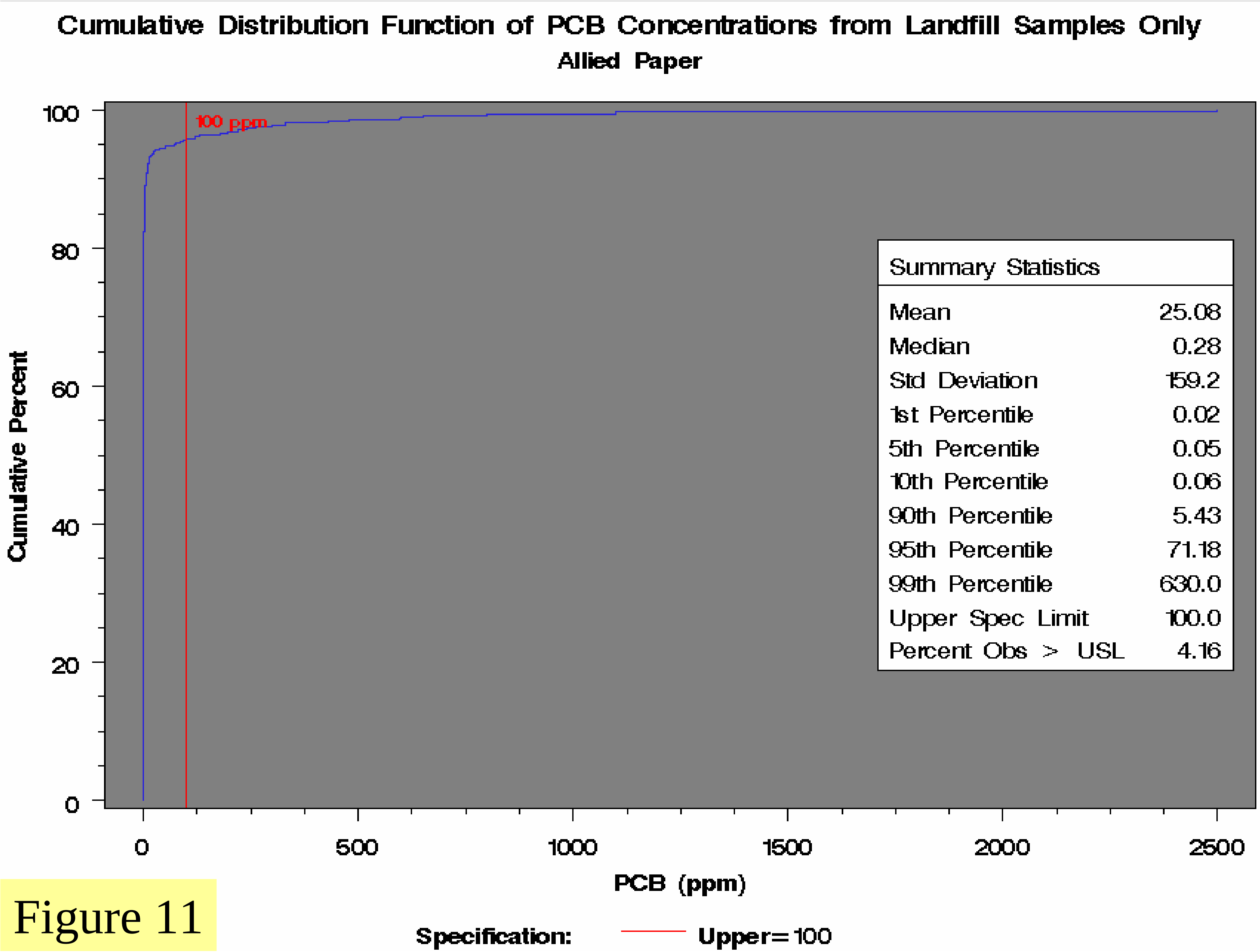
Figure 9


Allied Paper - PCB Sample Locations from Landfill Only
Legend
PCB Concentration (ppm)
0.00 - 9.99
10.00 - 49.99
50.00 - 99.99
100.00 - 499.99
500.00 - 2500.00
FIELDS
0
250
500
1,000
1,500
2,000
Feet



Cumulative Distribution Function of PCB Concentrations from Landfill Samples Only
Allied Paper
Cumulative Percent
0
20
40
60
80
100
0
500
1000
1500
2000
2500
PCB (ppm)
50 ppm
Summary Statistics
Mean 25.08
Median 0.28
Std Deviation 159.2
1st Percentile 0.02
5th Percentile 0.05
10th Percentile 0.06
90th Percentile 5.43
95th Percentile 71.18
99th Percentile 630.0
Upper Spec Limit 50.00
Percent Obs > USL 5.60
Specification: Upper=50

Figure 10



Cumulative Distribution Function of PCB Concentrations from Landfill Samples Only
Allied Paper
100 ppm
Cumulative Percent
PCB (ppm)
0
20
40
60
80
100
0
500
1000
1500
2000
2500
Summary Statistics
Mean 25.08
Median 0.28
Std Deviation 159.2
1st Percentile 0.02
5th Percentile 0.05
10th Percentile 0.06
90th Percentile 5.43
95th Percentile 71.18
99th Percentile 630.0
Upper Spec Limit 100.0
Percent Obs > USL 4.16
Specification: Upper=100

Figure 11

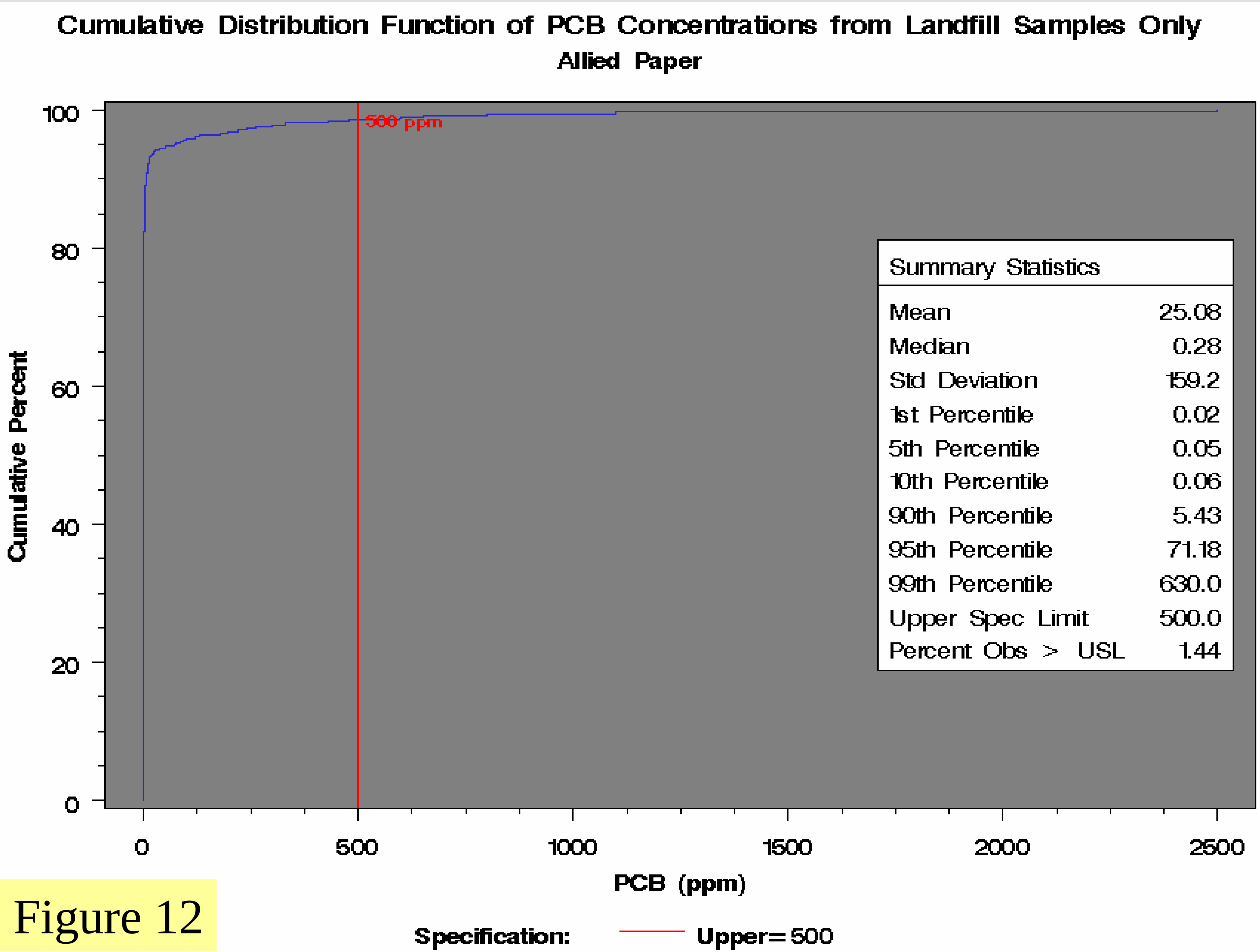

Cumulative Distribution Function of PCB Concentrations from Landfill Samples Only
Allied Paper
Cumulative Percent
100
80
60
40
20
0
500 ppm
Summary Statistics
Mean 25.08
Median 0.28
Std Deviation 159.2
1st Percentile 0.02
5th Percentile 0.05
10th Percentile 0.06
90th Percentile 5.43
95th Percentile 71.18
99th Percentile 630.0
Upper Spec Limit 500.0
Percent Obs > USL 1.44
0
500
1000
1500
2000
2500
PCB (ppm)
Specification:
Upper=500

Figure 12

Figure 13

Allied Paper - PCB Sample Locations from Western Landfill Only

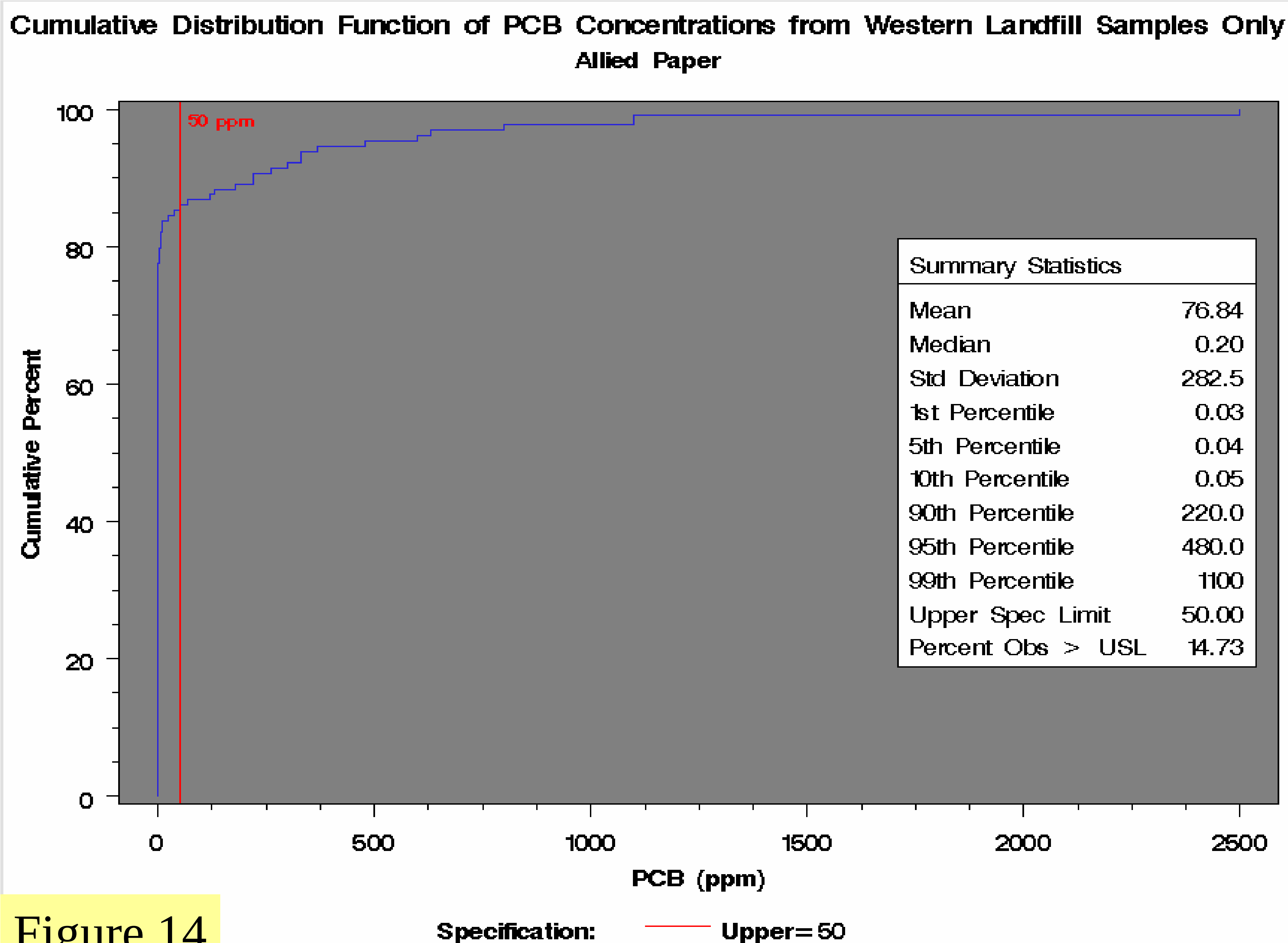

Cumulative Distribution Function of PCB Concentrations from Western Landfill Samples Only
Allied Paper
50 ppm
Cumulative Percent
PCB (ppm)
0
20
40
60
80
100
0
500
1000
1500
2000
2500
Summary Statistics
Mean 76.84
Median 0.20
Std Deviation 282.5
1st Percentile 0.03
5th Percentile 0.04
10th Percentile 0.05
90th Percentile 220.0
95th Percentile 480.0
99th Percentile 1100
Upper Spec Limit 50.00
Percent Obs > USL 14.73
Specification: Upper=50

Figure 14

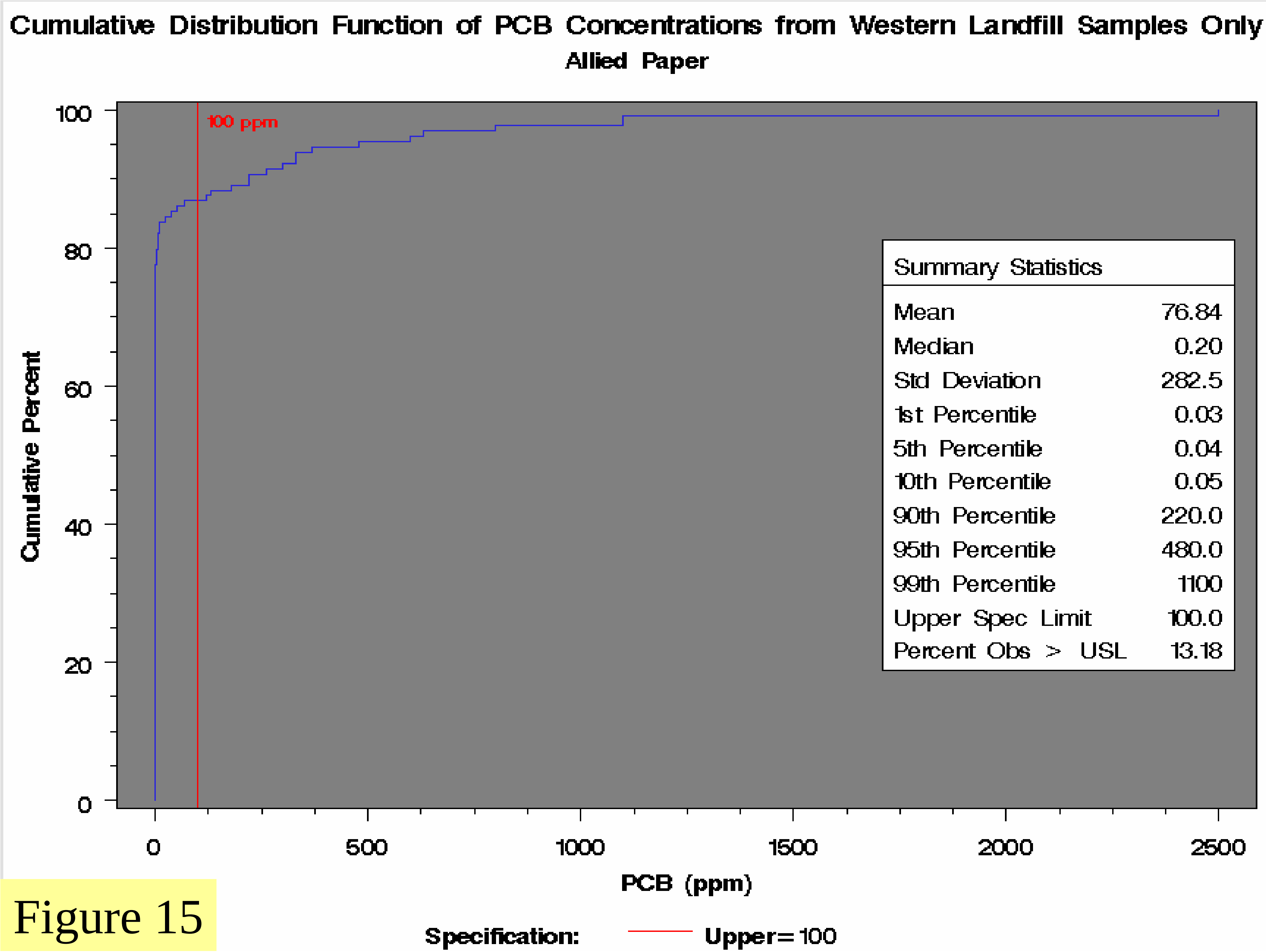

Cumulative Distribution Function of PCB Concentrations from Western Landfill Samples Only
Allied Paper
100 ppm
Cumulative Percent
0
20
40
60
80
100
0
500
1000
1500
2000
2500
PCB (ppm)
Summary Statistics
Mean 76.84
Median 0.20
Std Deviation 282.5
1st Percentile 0.03
5th Percentile 0.04
10th Percentile 0.05
90th Percentile 220.0
95th Percentile 480.0
99th Percentile 1100
Upper Spec Limit 100.0
Percent Obs > USL 13.18
Specification:
Upper=100

Figure 15

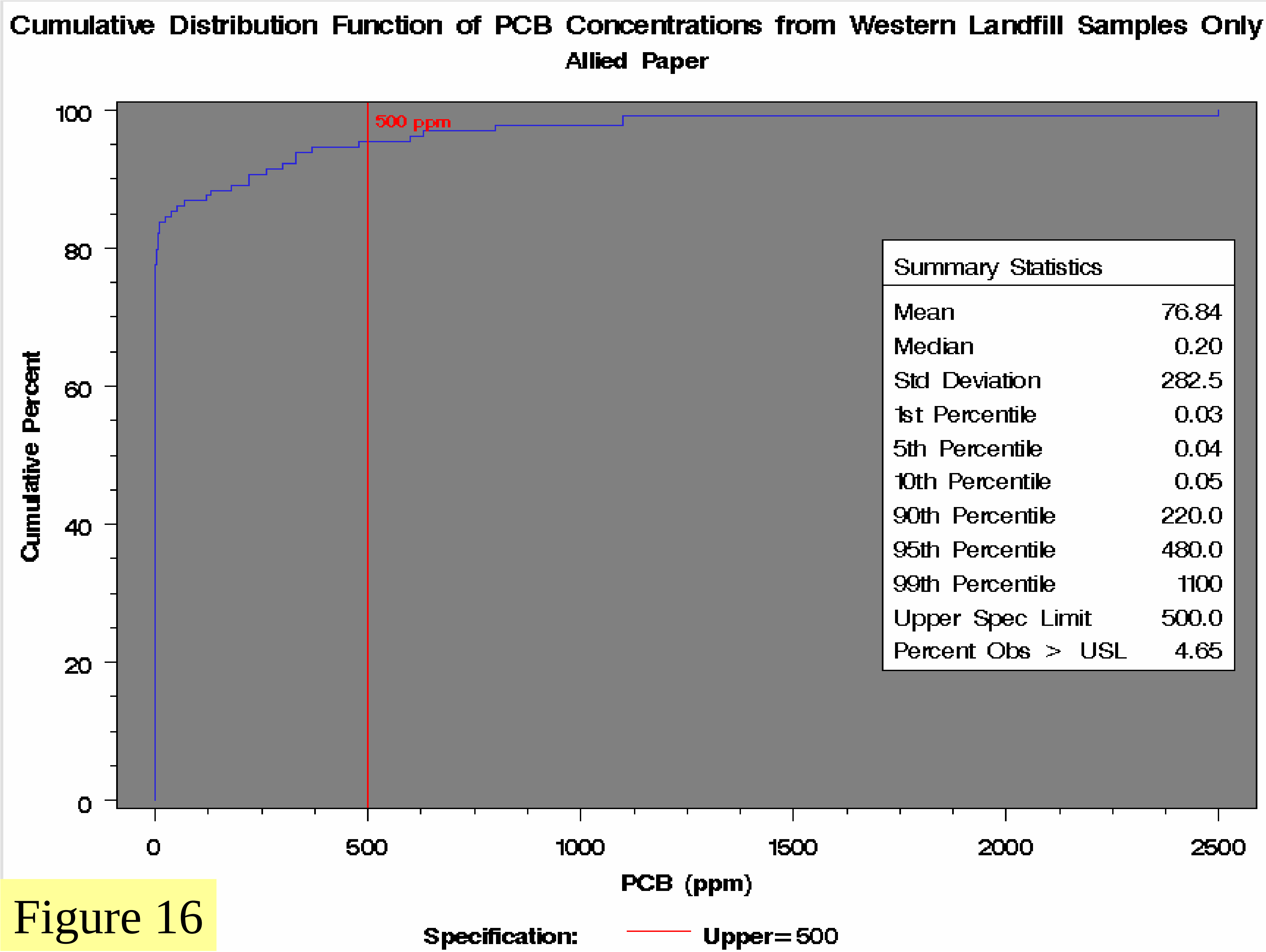

Cumulative Distribution Function of PCB Concentrations from Western Landfill Samples Only
Allied Paper
500 ppm
Cumulative Percent
0
20
40
60
80
100
0
500
1000
1500
2000
2500
PCB (ppm)
Summary Statistics
Mean 76.84
Median 0.20
Std Deviation 282.5
1st Percentile 0.03
5th Percentile 0.04
10th Percentile 0.05
90th Percentile 220.0
95th Percentile 480.0
99th Percentile 1100
Upper Spec Limit 500.0
Percent Obs > USL 4.65
Specification: Upper=500

Figure 16

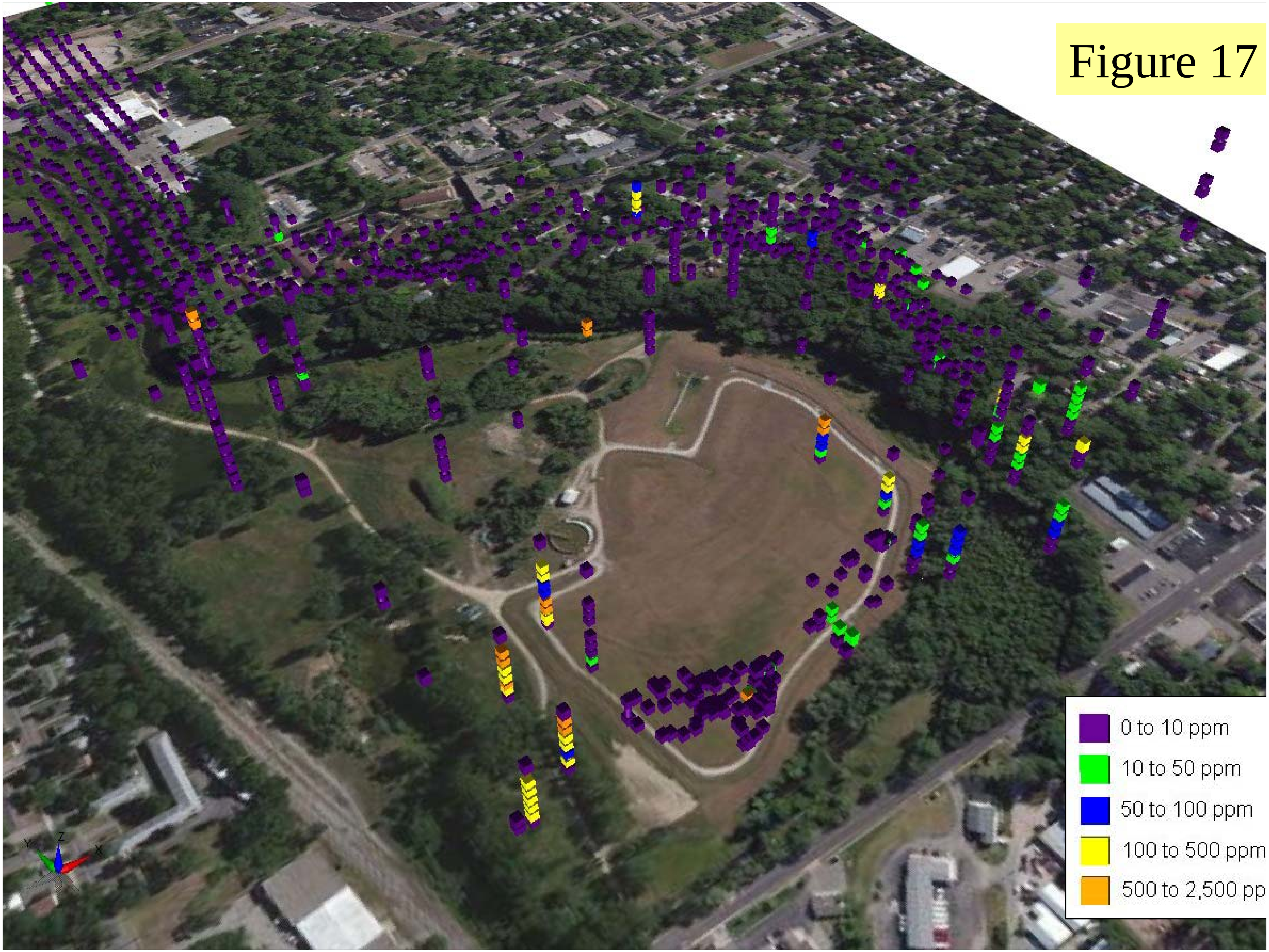
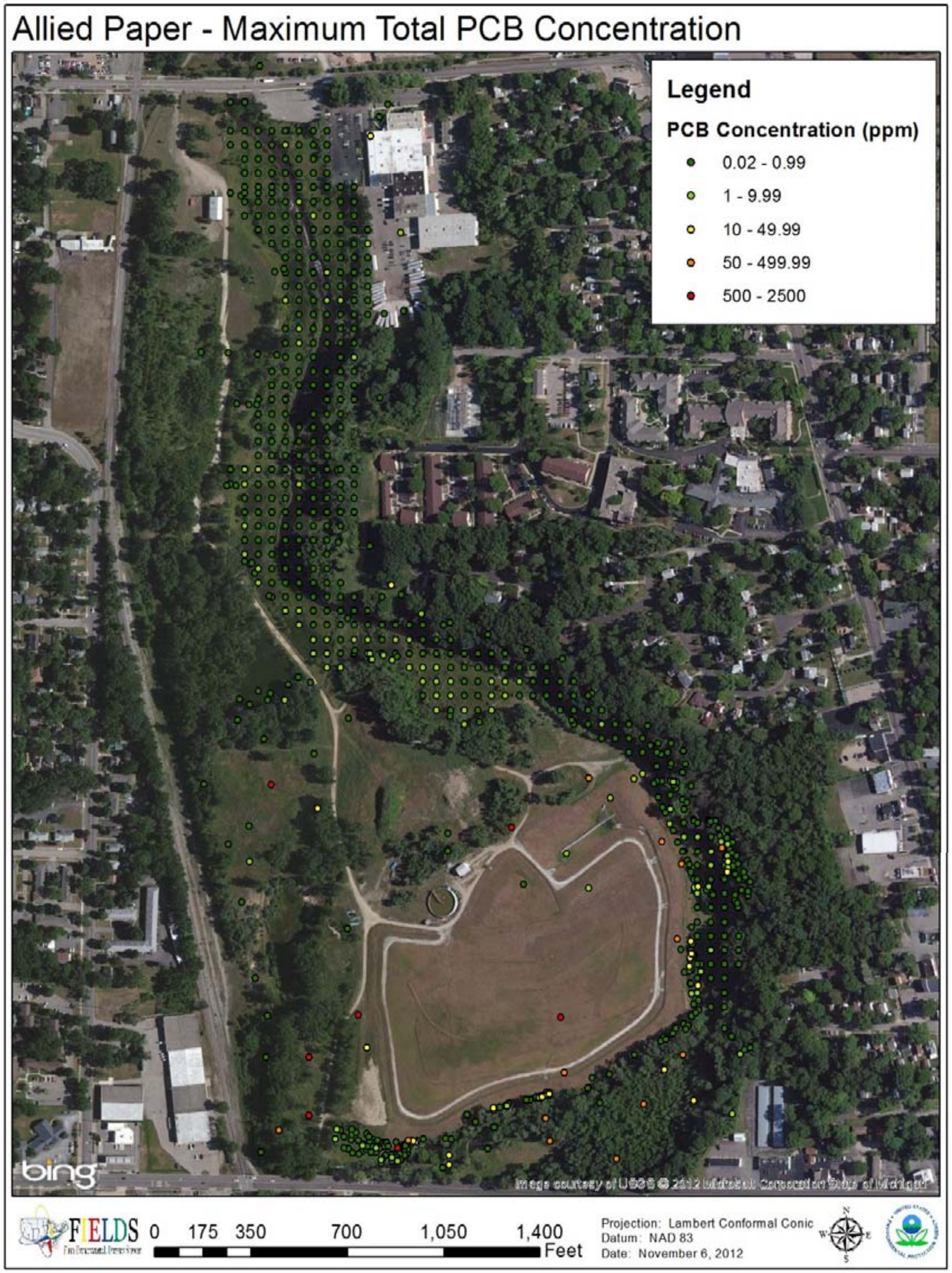


Figure 17
0 to 10 ppm
10 to 50 ppm
50 to 100 ppm
100 to 500 ppm
500 to 2,500 pp
Y
Z
X

Figure 18



Allied Paper - Maximum Total PCB Concentration
Legend
PCB Concentration (ppm)
0.02 - 0.99
1 - 9.99
10 - 49.99
50 - 499.99
500 - 2500
bing
FIELDS
0 175 350 700 1,050 1,400 Feet
Projection: Lambert Conformal Conic
Datum: NAD 83
Date: November 6, 2012

Figure 19

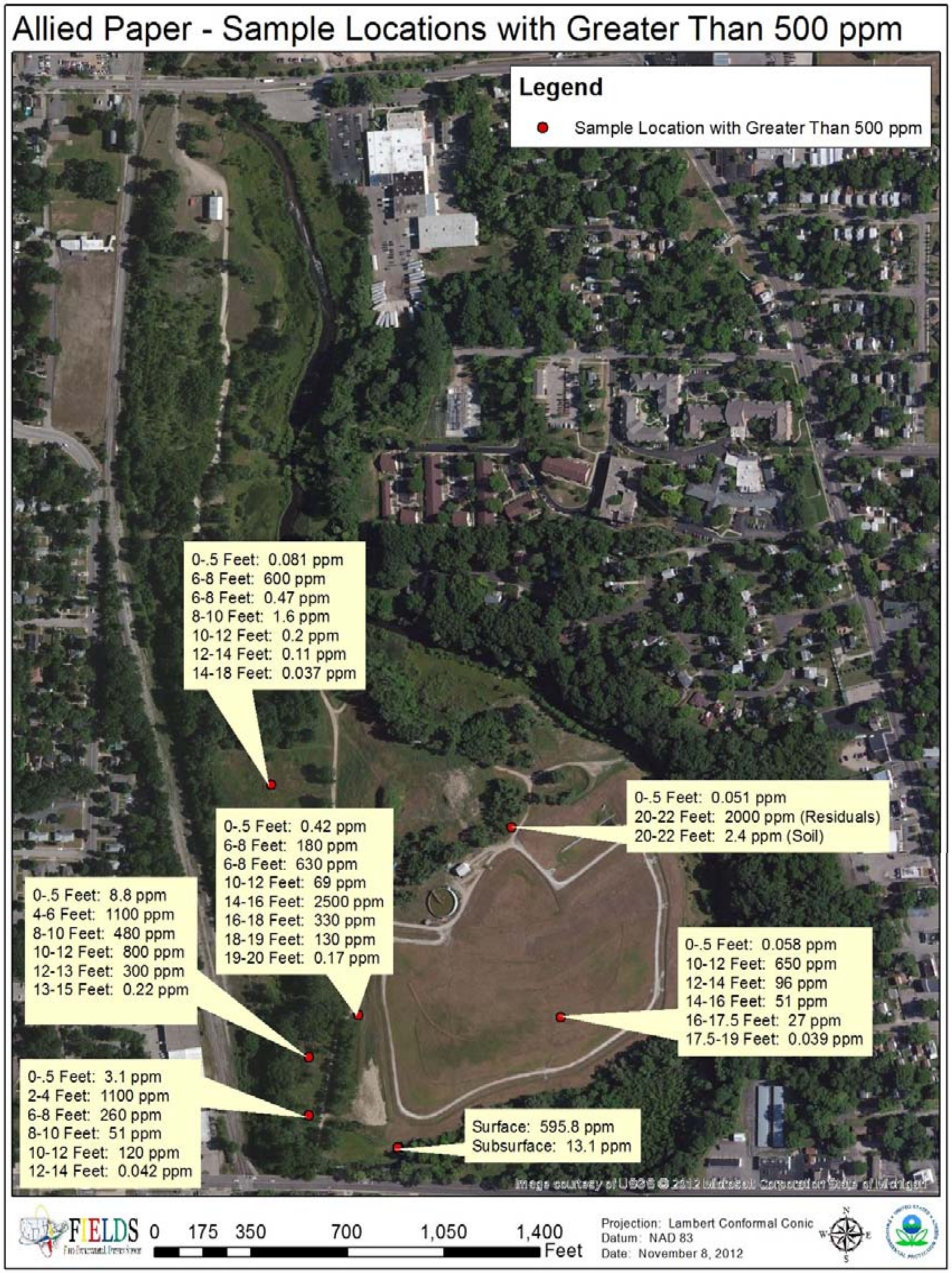
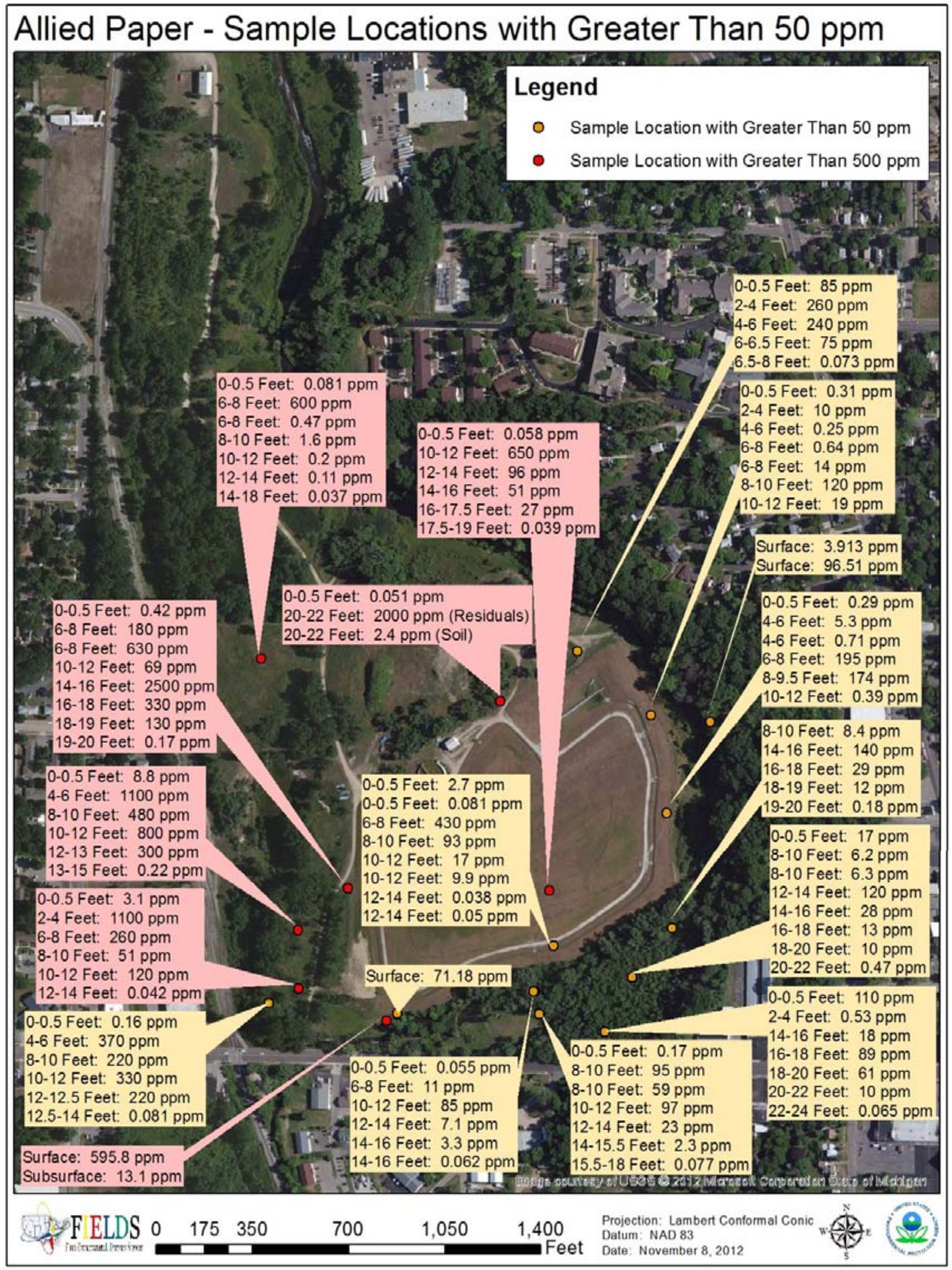

Allied Paper - Sample Locations with Greater Than 500 ppm
Legend
Sample Location with Greater Than 500 ppm
0-.5 Feet: 0.081 ppm
6-8 Feet: 600 ppm
6-8 Feet: 0.47 ppm
8-10 Feet: 1.6 ppm
10-12 Feet: 0.2 ppm
12-14 Feet: 0.11 ppm
14-18 Feet: 0.037 ppm
0-.5 Feet: 0.051 ppm
20-22 Feet: 2000 ppm (Residuals)
20-22 Feet: 2.4 ppm (Soil)
0-.5 Feet: 0.42 ppm
6-8 Feet: 180 ppm
6-8 Feet: 630 ppm
10-12 Feet: 69 ppm
14-16 Feet: 2500 ppm
16-18 Feet: 330 ppm
18-19 Feet: 130 ppm
19-20 Feet: 0.17 ppm
0-.5 Feet: 8.8 ppm
4-6 Feet: 1100 ppm
8-10 Feet: 480 ppm
10-12 Feet: 800 ppm
12-13 Feet: 300 ppm
13-15 Feet: 0.22 ppm
0-.5 Feet: 0.058 ppm
10-12 Feet: 650 ppm
12-14 Feet: 96 ppm
14-16 Feet: 51 ppm
16-17.5 Feet: 27 ppm
17.5-19 Feet: 0.039 ppm
0-.5 Feet: 3.1 ppm
2-4 Feet: 1100 ppm
6-8 Feet: 260 ppm
8-10 Feet: 51 ppm
10-12 Feet: 120 ppm
12-14 Feet: 0.042 ppm
Surface: 595.8 ppm
Subsurface: 13.1 ppm
FIELDS
0 175 350 700 1,050 1,400
Feet
Projection: Lambert Conformal Conic
Datum: NAD 83
Date: November 8, 2012

Figure 20



Allied Paper - Sample Locations with Greater Than 50 ppm
Legend
Sample Location with Greater Than 50 ppm
Sample Location with Greater Than 500 ppm
0-0.5 Feet: 85 ppm
2-4 Feet: 260 ppm
4-6 Feet: 240 ppm
6-6.5 Feet: 75 ppm
6.5-8 Feet: 0.073 ppm
0-0.5 Feet: 0.081 ppm
6-8 Feet: 600 ppm
6-8 Feet: 0.47 ppm
8-10 Feet: 1.6 ppm
10-12 Feet: 0.2 ppm
12-14 Feet: 0.11 ppm
14-18 Feet: 0.037 ppm
0-0.5 Feet: 0.058 ppm
10-12 Feet: 650 ppm
12-14 Feet: 96 ppm
14-16 Feet: 51 ppm
16-17.5 Feet: 27 ppm
17.5-19 Feet: 0.039 ppm
0-0.5 Feet: 0.31 ppm
2-4 Feet: 10 ppm
4-6 Feet: 0.25 ppm
6-8 Feet: 0.64 ppm
6-8 Feet: 14 ppm
8-10 Feet: 120 ppm
10-12 Feet: 19 ppm
Surface: 3.913 ppm
Surface: 96.51 ppm
0-0.5 Feet: 0.051 ppm
20-22 Feet: 2000 ppm (Residuals)
20-22 Feet: 2.4 ppm (Soil)
0-0.5 Feet: 0.42 ppm
6-8 Feet: 180 ppm
6-8 Feet: 630 ppm
10-12 Feet: 69 ppm
14-16 Feet: 2500 ppm
16-18 Feet: 330 ppm
18-19 Feet: 130 ppm
19-20 Feet: 0.17 ppm
0-0.5 Feet: 0.29 ppm
4-6 Feet: 5.3 ppm
4-6 Feet: 0.71 ppm
6-8 Feet: 195 ppm
8-9.5 Feet: 174 ppm
10-12 Feet: 0.39 ppm
8-10 Feet: 8.4 ppm
14-16 Feet: 140 ppm
16-18 Feet: 29 ppm
18-19 Feet: 12 ppm
19-20 Feet: 0.18 ppm
0-0.5 Feet: 8.8 ppm
4-6 Feet: 1100 ppm
8-10 Feet: 480 ppm
10-12 Feet: 800 ppm
12-13 Feet: 300 ppm
13-15 Feet: 0.22 ppm
0-0.5 Feet: 2.7 ppm
0-0.5 Feet: 0.081 ppm
6-8 Feet: 430 ppm
8-10 Feet: 93 ppm
10-12 Feet: 17 ppm
10-12 Feet: 9.9 ppm
12-14 Feet: 0.038 ppm
12-14 Feet: 0.05 ppm
0-0.5 Feet: 17 ppm
8-10 Feet: 6.2 ppm
8-10 Feet: 6.3 ppm
12-14 Feet: 120 ppm
14-16 Feet: 28 ppm
16-18 Feet: 13 ppm
18-20 Feet: 10 ppm
20-22 Feet: 0.47 ppm
0-0.5 Feet: 3.1 ppm
2-4 Feet: 1100 ppm
6-8 Feet: 260 ppm
8-10 Feet: 51 ppm
10-12 Feet: 120 ppm
12-14 Feet: 0.042 ppm
Surface: 71.18 ppm
0-0.5 Feet: 110 ppm
2-4 Feet: 0.53 ppm
14-16 Feet: 18 ppm
16-18 Feet: 89 ppm
18-20 Feet: 61 ppm
20-22 Feet: 10 ppm
22-24 Feet: 0.065 ppm
0-0.5 Feet: 0.16 ppm
4-6 Feet: 370 ppm
8-10 Feet: 220 ppm
10-12 Feet: 330 ppm
12-12.5 Feet: 220 ppm
12.5-14 Feet: 0.081 ppm
0-0.5 Feet: 0.055 ppm
6-8 Feet: 11 ppm
10-12 Feet: 85 ppm
12-14 Feet: 7.1 ppm
14-16 Feet: 3.3 ppm
14-16 Feet: 0.062 ppm
0-0.5 Feet: 0.17 ppm
8-10 Feet: 95 ppm
8-10 Feet: 59 ppm
10-12 Feet: 97 ppm
12-14 Feet: 23 ppm
14-15.5 Feet: 2.3 ppm
15.5-18 Feet: 0.077 ppm
Surface: 595.8 ppm
Subsurface: 13.1 ppm
FIELDS
0 175 350 700 1,050 1,400 Feet
Projection: Lambert Conformal Conic
Datum: NAD 83
Date: November 8, 2012

Figure 21

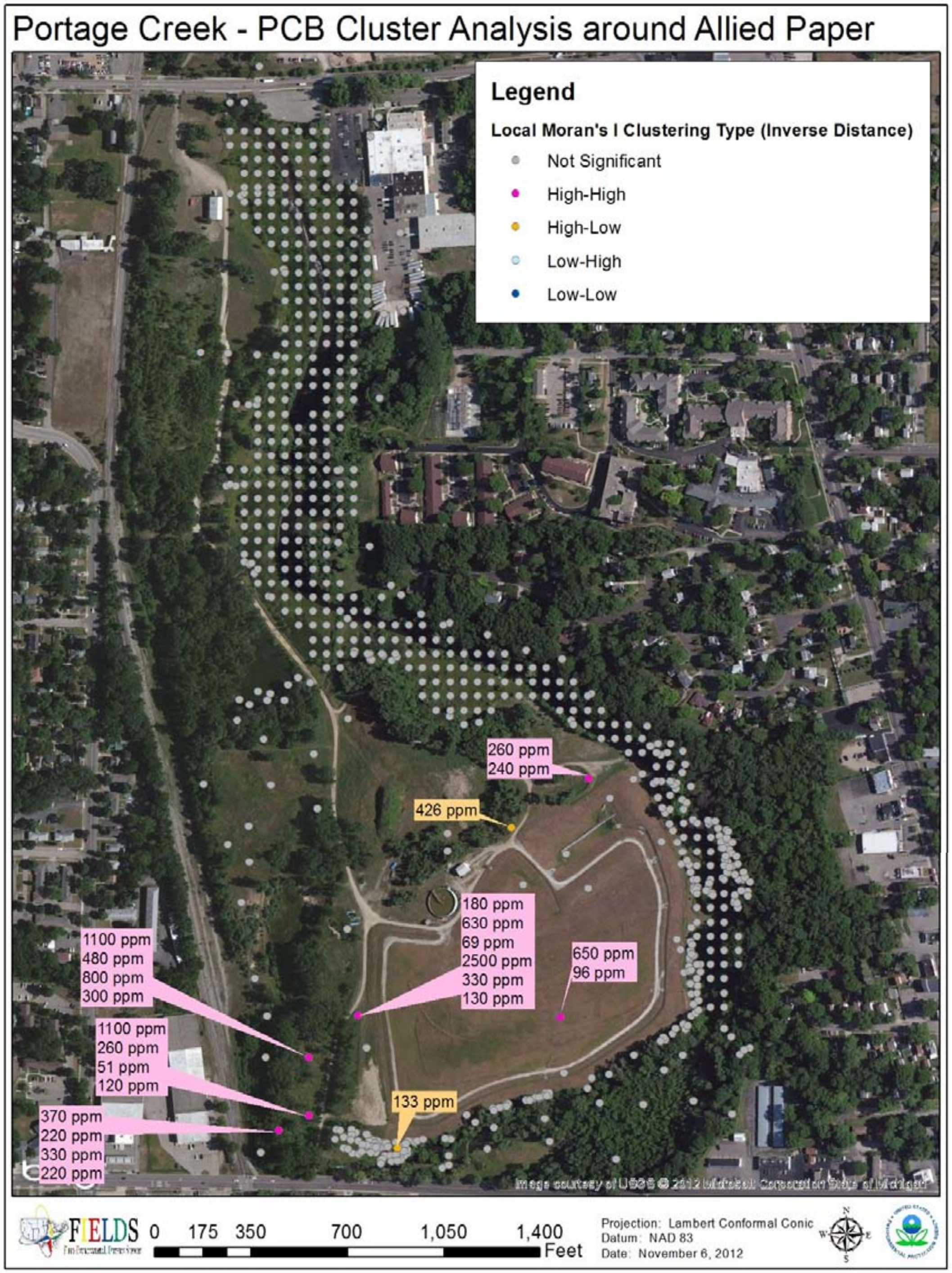

Portage Creek - PCB Cluster Analysis around Allied Paper
Legend
Local Moran's I Clustering Type (Inverse Distance)
Not Significant
High-High
High-Low
Low-High
Low-Low
260 ppm
240 ppm
426 ppm
180 ppm
630 ppm
69 ppm
2500 ppm
330 ppm
130 ppm
650 ppm
96 ppm
1100 ppm
480 ppm
800 ppm
300 ppm
1100 ppm
260 ppm
51 ppm
120 ppm
370 ppm
220 ppm
330 ppm
220 ppm
133 ppm
FIELDS
0 175 350 700 1,050 1,400
Feet
Projection: Lambert Conformal Conic
Datum: NAD 83
Date: November 6, 2012

Figure 22

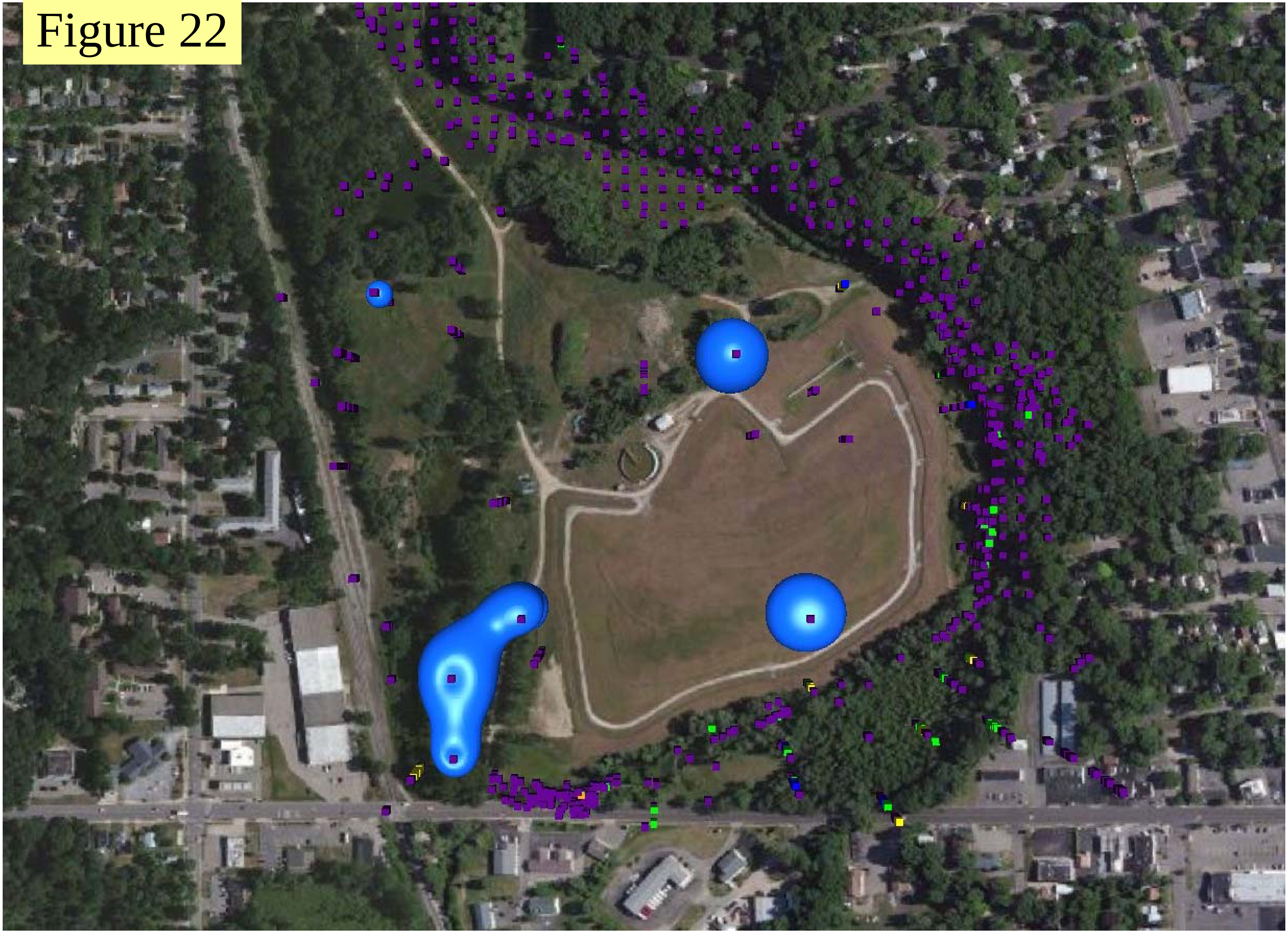


Figure 23

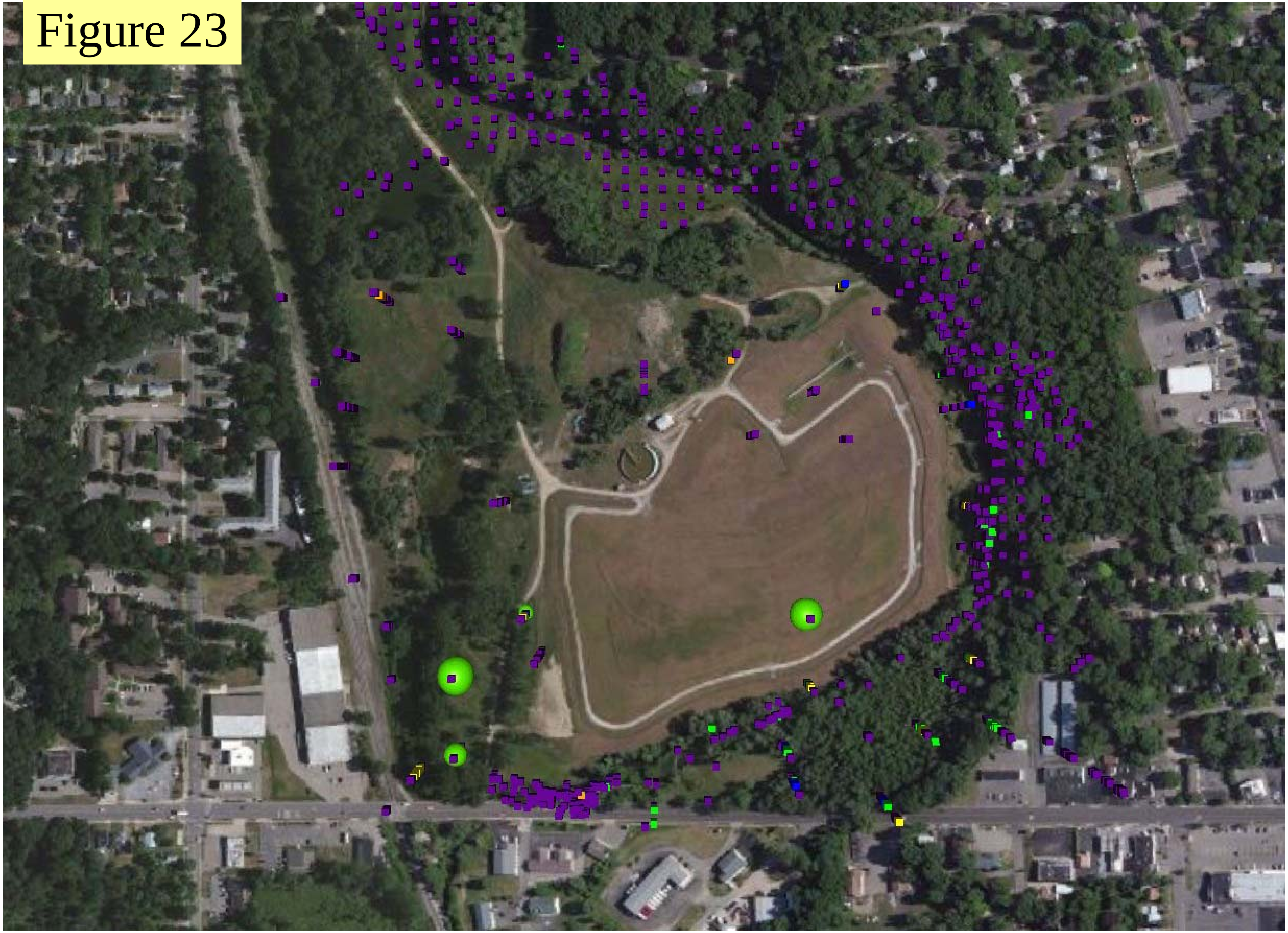


Figure 24

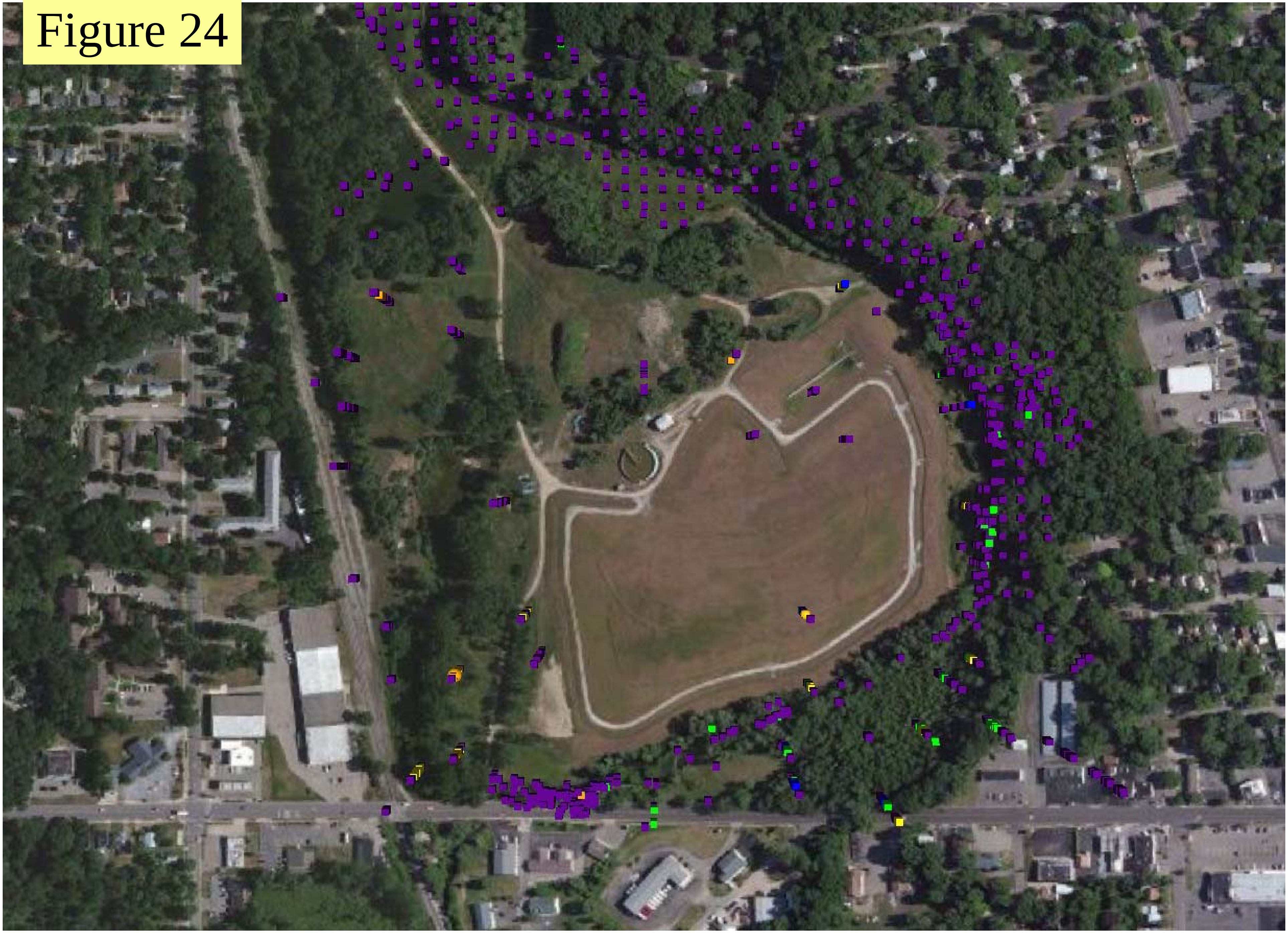


Table I

Hotspot Size Radius (ft)	Hotspot Size Diameter (ft)	Probability of Missing Hotspot	Number of Samples	Number of Analyses*
2	4	5%	217,082	2,170,820
3	6	5%	96,481	964,810
6	12	5%	24,120	241,200
12.5	25	5%	5,557	55,570
25	50	5%	1,389	13,890
50	100	5%	343	3,430
100	200	5%	88	880
200	400	5%	22	220
400	800	5%	6	60

* Number of analyses assumes that 10 intervals would be collected from each core and submitted for laboratory analysis.

Figure 25

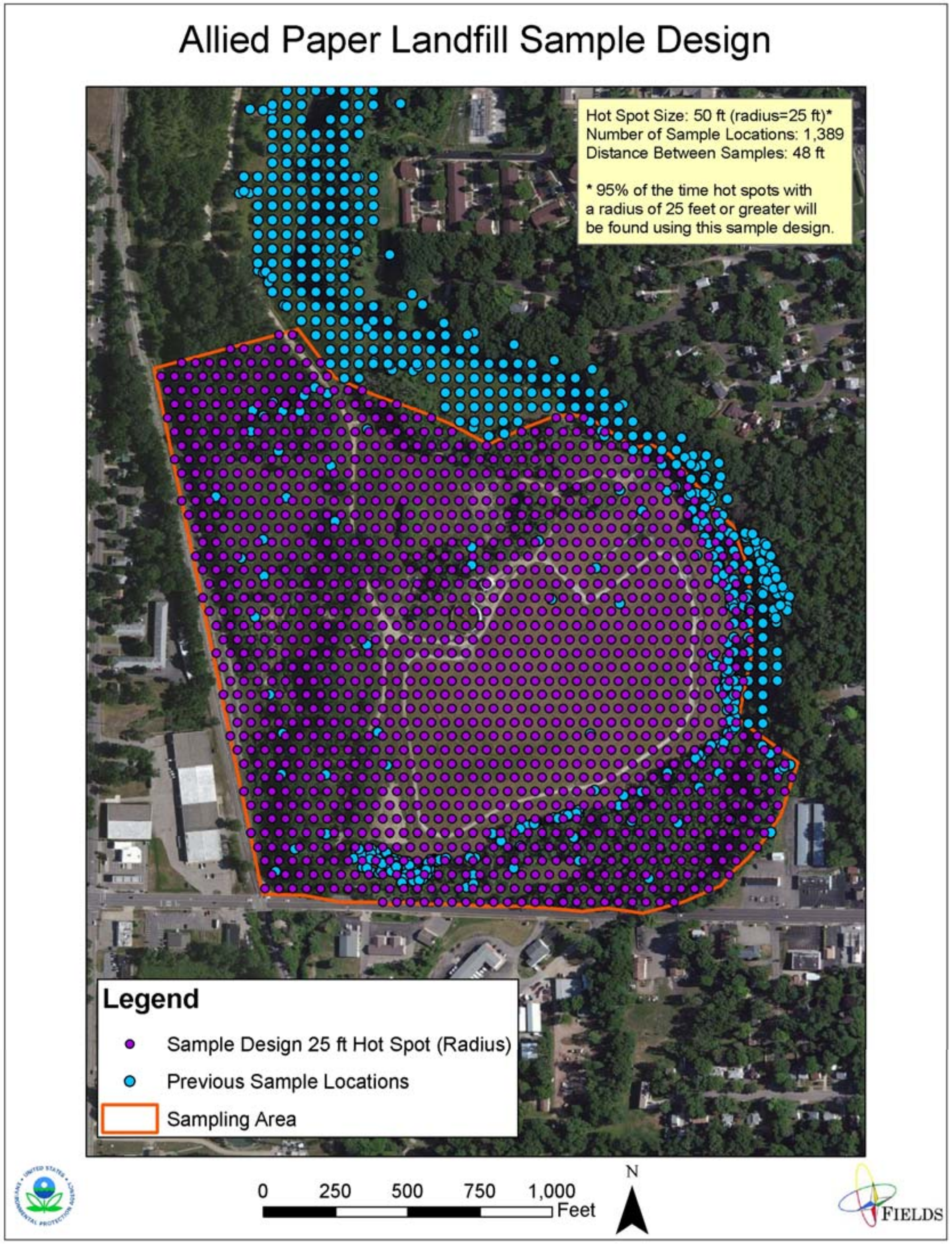
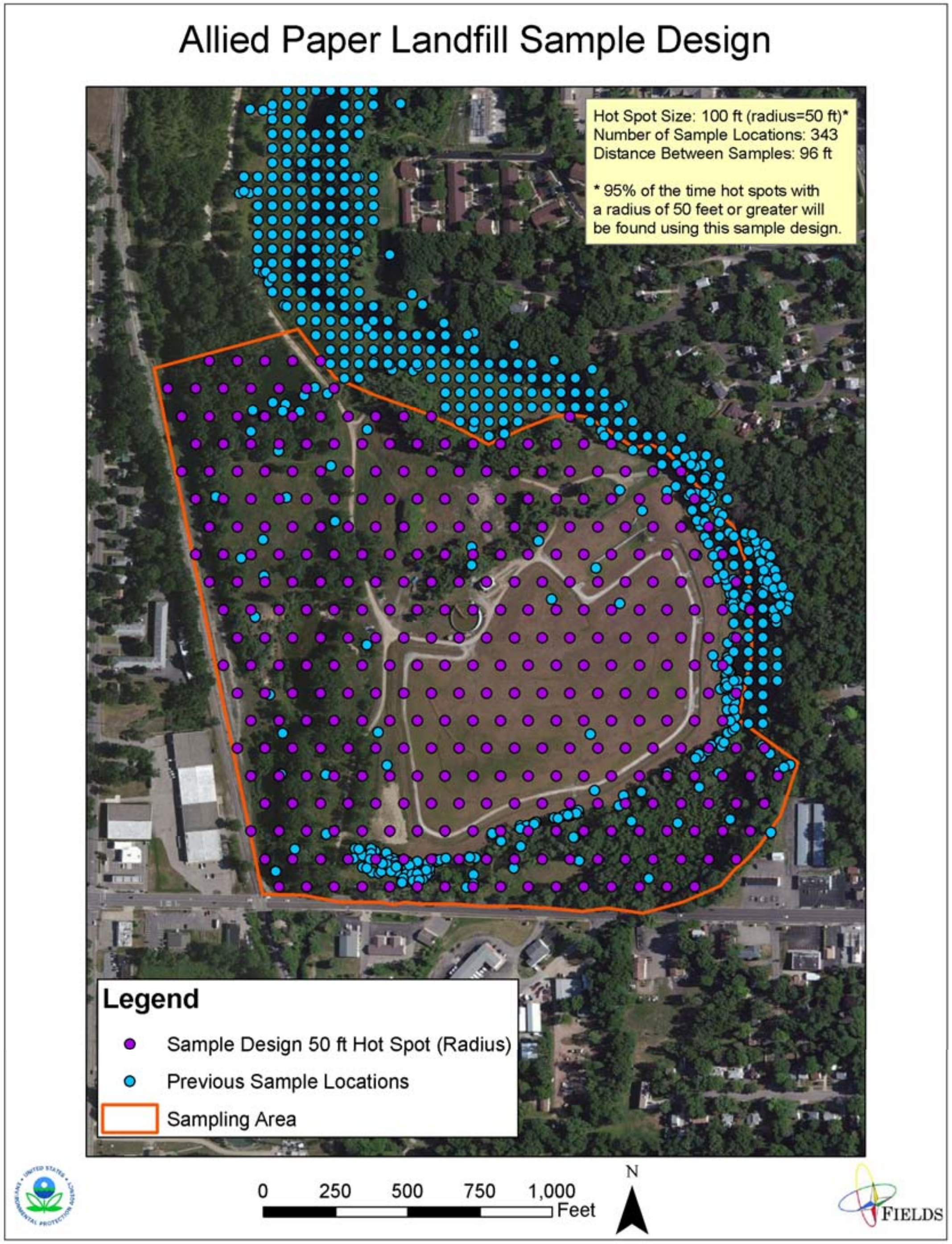
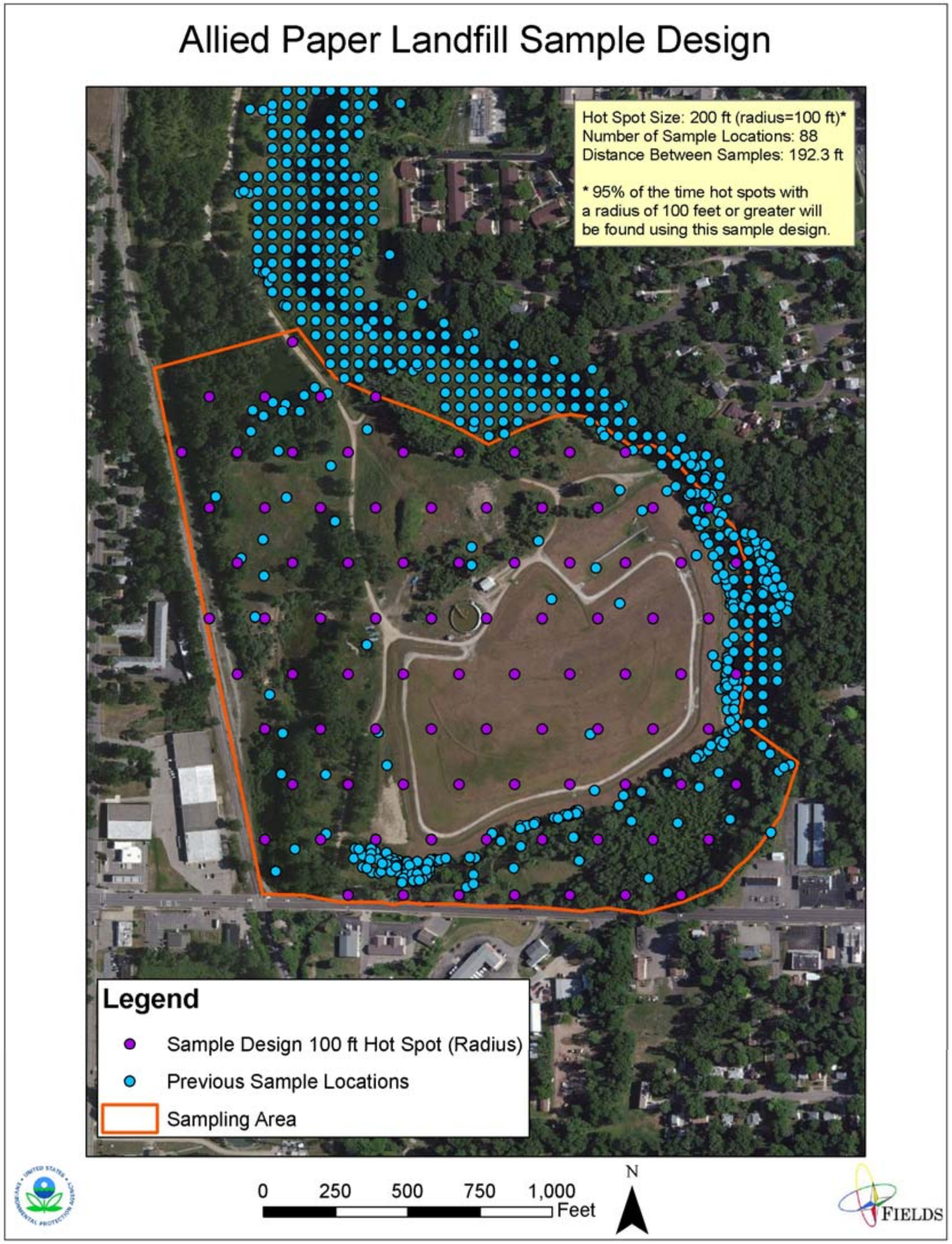

Allied Paper Landfill Sample Design
Hot Spot Size: 50 ft (radius=25 ft)*
Number of Sample Locations: 1,389
Distance Between Samples: 48 ft
* 95% of the time hot spots with
a radius of 25 feet or greater will
be found using this sample design.
Legend
Sample Design 25 ft Hot Spot (Radius)
Previous Sample Locations
Sampling Area
0
250
500
750
1,000
Feet
N
FIELDS

Figure 26



Allied Paper Landfill Sample Design
Hot Spot Size: 100 ft (radius=50 ft)*
Number of Sample Locations: 343
Distance Between Samples: 96 ft
* 95% of the time hot spots with a radius of 50 feet or greater will be found using this sample design.
Legend
Sample Design 50 ft Hot Spot (Radius)
Previous Sample Locations
Sampling Area
0 250 500 750 1,000
Feet
N
FIELDS

Figure 27



Allied Paper Landfill Sample Design
Hot Spot Size: 200 ft (radius=100 ft)*
Number of Sample Locations: 88
Distance Between Samples: 192.3 ft
* 95% of the time hot spots with a radius of 100 feet or greater will be found using this sample design.
Legend
Sample Design 100 ft Hot Spot (Radius)
Previous Sample Locations
Sampling Area
0
250
500
750
1,000
Feet
N
FIELDS